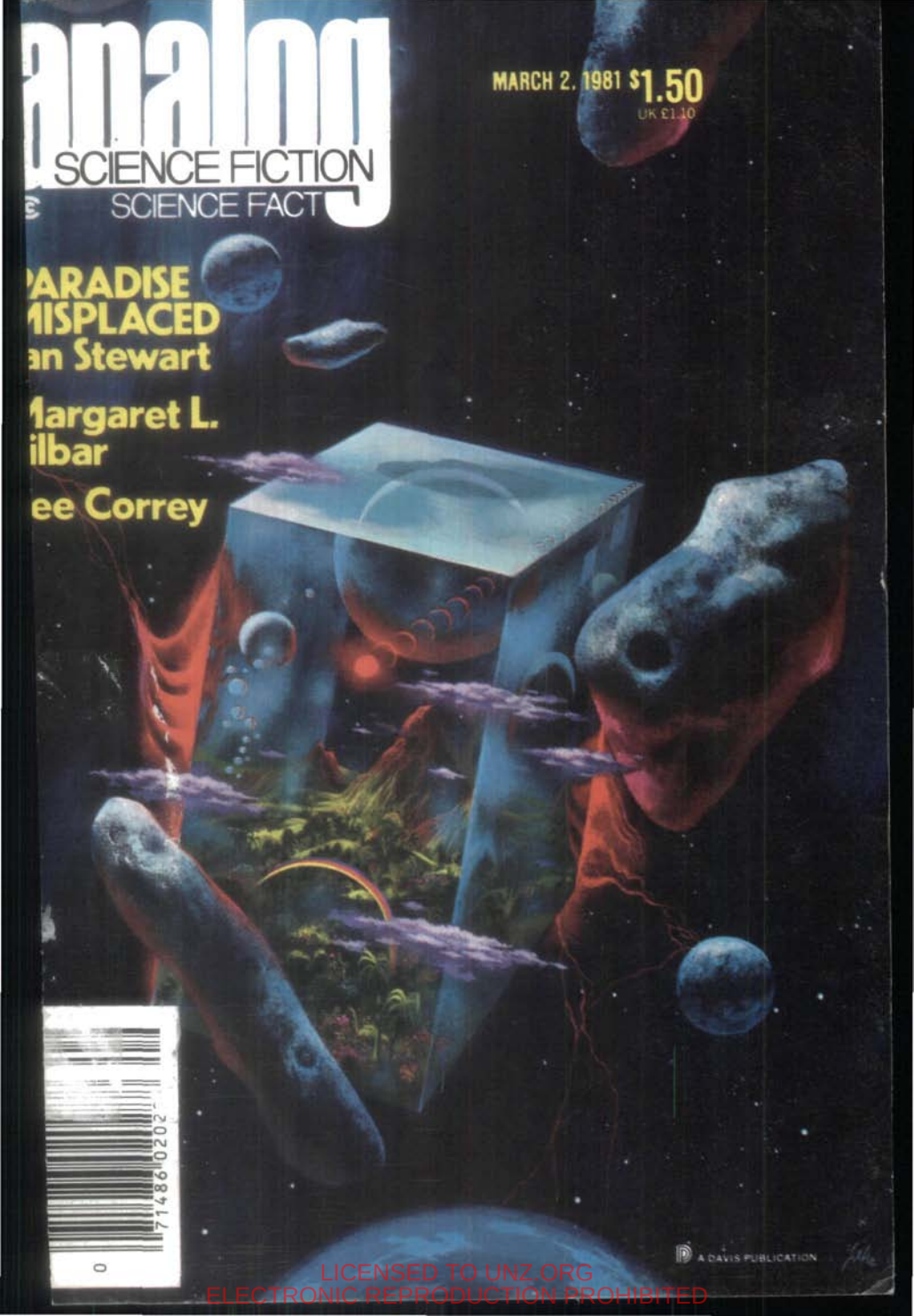

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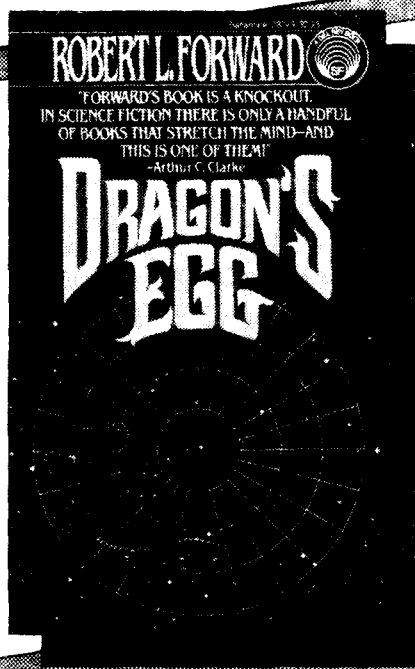
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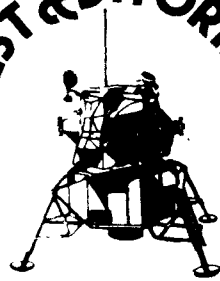
IS OHM KILLING THE SPACE PROGRAM?

GUEST EDITORIAL



BY STEPHEN A. KALLIS

The space program is dying a slow and terribly lingering death. A little is trimmed from the budget here, a program is slipped there, and a project is cancelled. Why?

There are many reasons, but chief among them is lack of understanding, both by the proponents of space flight, and by the part of the general public that hasn't already got stuck with the bill. The cost of these understandings [illegible] the space program will [illegible].

The true proponents of space flight [illegible] talked about it before [illegible] and Project Vanguard) read Arthur C. Clarke and Willy Ley. They believe. To them the idea of going into space was simply a manifestation of the same urge that drove explorers to see what was on the other side of a mountain. "Because it's there," was and is a trite phrase, but it "explains" by its very vagueness the emotion that underlies a great deal of exploration.

During the period after World War II, there was a lot of "scientific" activity, including nuclear tests, the development of a string of new jet aircraft, and high altitude shots of rockets (many of them captured V-2s). So the idea of an artificial satellite was not altogether astounding, even to the general public.

What was a shock was *Sputnik*. Sputnik did a lot of things, not the least of which was to scare the American public. Suddenly, something that seemed to be the United States' private domain (particularly after the spate of science fiction movies, starting with *Destination Moon* and generally after that going downhill) was preempted by someone who could be an implacable foe. That was frightening!

Starting from that point, the United

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States had to do something to catch up and regain the lead. And what with the Russians dusting off some articles about manned space flights, was it any wonder that the United States' effort would culminate in Project Apollo?

And so the advent of Project Apollo [illegible] to sour. I don't mean that [illegible] wrong nor that it [illegible] attempted. But the [illegible] to the public was [illegible]

[illegible] sold as an adventure. It [illegible] to be sure, but it was [illegible] that way. The real [illegible] paying public [illegible] were a taxpayer or [illegible] engineer work[illegible] allied fields [illegible] dollar was being [illegible] space program the reply [illegible] something like. "To [illegible] the greatest adventure of [illegible] sounding words, but [illegible] them the seeds for the [illegible] space program.

[illegible] adventure is something you do [illegible] Hillary climbed Mount [illegible] Lindbergh flew the Atlantic nonstop and solo once. An adventure is doing it "because it's there," but having done it once, you've proved your point.

When Apollo XII was launched towards the moon, one of my friends, who was a college graduate but not technologically oriented, asked me, "Why are they going back? They've already been there." In his mind, the great crusade was done with Apollo XI.

The media cooperated with NASA. Every space shot was promoted as an adventure and nothing else. No byproducts of the space effort were featured.

A shift in perspective: when I entered the space program, one of my supervisors told me, "The United States wants to keep a strong space program. So, if one company isn't getting enough of a share, they'll get a contract to sort of even things up." At the time, I also heard a refrain that went something like, "You can't turn research on and off like a faucet."

Both were complacent attitudes, but why not? In NASA's original view, the horizons were limitless. Tomorrow, the moon; the day after, Mars. Nothing was impossible, and rocket technology was becoming more than acceptable.

There were many people in the space program who told each other that their work was important; perhaps, in the cosmic sense, it was and is. However, "important" is a relative term. To, say, a baseball fan, it's important that the favorite team win the pennant; but to someone who doesn't like the game, it's of no importance whatsoever. If the average mountain man of the time had heard of the discovery of the Rosetta Stone, would he have been likely to care?

Now, in the science fiction magazines of the time, the space program was discussed as being important. Why not? The readers were already convinced.

When the public agreed that it was "important," they did so on the basis that it was important that the United States catch up with and surpass the Russians. Whether it was important to be in space at all was never discussed publicly, except among the believers.

Another shift: there's the Proxmire

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phenomenon. It is well known that Senator Proxmire thinks (and probably correctly) that a great deal of taxpayer money is being misspent. This tends to be reinforced by instances of government grants being milked by academics in some cases; this is not a blanket indictment, but how many rotten cops on a police force make all cops look bad? The problem is that without sufficient knowledge, a number of perfectly sound programs can sound very silly. (Imagine Fleming before a Proxmire type: "Do I understand that you want all this money just to study *bread mold?*")

I have no doubt that the senator feels that he's performing a great public service, and that he is perfectly sincere. That doesn't mean that he can't do the space program a great deal of harm if he doesn't understand the purpose and payback of the space program. And he knows no less than the average taxpayer.

Let's talk for a moment about payback. All research has payback, though in some cases, it's with negative knowledge. The byproducts of the space program are many, but who knows?

Once the program started to slip, people within it started to look around to see what the results—byproducts, spinoffs—of the space program were. They found many, ranging from remote sensing of medical subjects to new cookware material.

So what happened to all the data? They were collected into little internal publications and were circulated throughout NASA. They were talking to themselves again. John Q. Public heard little, if any, of this (and what he did hear tended to be frivolous: who really cares whether a ball-point pen works in free fall unless you plan to take notes while skydiving?). And so the public remained uninformed.

Recall that to the average citizen, the result of any taxpayer-funded program should satisfactorily answer the question, "What's in it for me?" An unsatisfactory answer can kill the program.

The proponents of space flight have to listen. They have to explain what is in it for the taxpayer in terms the taxpayer will accept. Otherwise, the taxpayer may have the last word, through his or her elected representative. You may not be able to turn on research like a faucet, but you sure as Hell can turn it off: just stop the funding.

With these perspectives, what is happening today on the Space Frontier? There are two major projects being talked about: the L5 colony and the Solar Power Satellite (SPS). To the public, both seem superfluous, and one may even seem a bit dangerous.

Take the L5 colony. The idea of a large artificial structure in a Trojan position with the moon and the Earth, peopled by hundreds, is hard enough for the average taxpayer to swallow. But the reasons for its assembly are sufficiently vague and silly-sounding to make a Proxmire type salivate. (You can perform manufacturing in space that would be difficult or impossible to do here on Earth. Like what? When pressed for an answer, the usual reply is, "Well, in zero gravity, it would be possible to manufacture perfect ball bearings." The senator pricks up his ears. "Do you mean to tell me that we are proposing to send hundreds to thousands of people a quarter of a million miles away from

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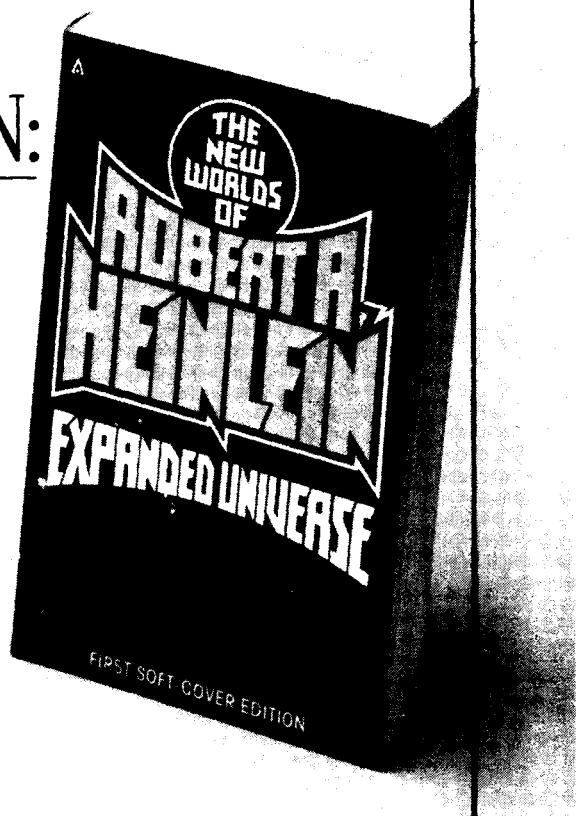

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this planet just to manufacture *ball bearings?*'')

I have some personal doubts about L5, but I can see some merit in it. The average taxpayer will see none. Certainly not as it's been presented. Consider the cost of L5, and then explain what's in it for the average taxpayer in terms that he or she will understand *and sympathize with*. Otherwise, it's a dead duck.

It can't even be presented as a Great Adventure. What manufacturing plant is?

Then there's the SPS. Imagine a huge satellite in geosynchronous orbit capturing the rays of the sun, converting them into a microwave beam that is directed to a field of receptor-converters that convert the beam into electricity.

If it ever gets past the ''paper'' stage, the environmentalists will eat the planners alive! On Cape Cod, the Otis Air Force Base recently instituted a Pave Paws (early warning) radar facility, and there were delays and demonstrations because of potential microwave contamination. Forget all other technical considerations (I have objections to this one, too, on technical merits), and think what the environmentalists can do. (''What if the beam wobbles?'' ''How do we know what such a sustained concentration of radio waves will do to the Ozone Layer?'' ''What about thermal pollution?'' ''How many migrating geese will be cooked flying through these beams?''—and that's just for starters.)

To find out what clout environmentalists have, ask any pilot, particularly the pilot of a large airliner, what he or she thinks of noise abatement procedures on takeoff.

To make the SPS viable, its proponents have to demonstrate to the public's satisfaction that it's a better, safer, and less expensive way to obtain much-needed energy than any of its rivals. And if the proponents can't do that, tieing the space program to it just makes the space program that much weaker.

Should the space program then be abandoned? No, but to survive, it will have to head in new directions. And those involved in it or in ''boosting'' it will have to learn to talk a little differently.

There are a few approaches that could be used. For example:

1. Private enterprise. Make it easier for private corporations to own launch vehicles and launch payloads. This takes the burden off the taxpayer directly. As well, it promotes competition, which increases design efficiency.

2. Expedition to Mars. *Not* sold primarily as an adventure, but as a test bed to solve a lot of problems. A Mars voyage would be totally out of range for help, so before it goes certain problems involved in making the trip would have to be solved. These include pollution and energy.

With our current technology, a Mars voyage will take years to complete. It would require something close to a Hohmann (minimum-energy) transfer orbit, both coming and going: each leg would take over 200 days, and over a year from launch would be required before the planets would be in proper position for a return. Thus, it would be virtually impossible to bring along enough oxygen to last the full voyage—except in the form of a closed ecosystem. The design would have to

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be so nearly perfect that the deviations from the norm would still be acceptable literally hundreds of days after being put into operation. Thus, if pollution isn't licked thoroughly within the closed system of the Mars expedition before it leaves, it won't return.

Apply that sort of technology (and its inevitable derivations) to Terrestrial life, and the problem of pollution throughout the world would be solved (in large part, anyway). That, alone, would answer "what's in it for J. Q. Public."

A similar case could be made for development of a compact, reliable power source to take care of human needs for the duration of the voyage. Unlike semiconductors, humans require a lot of power to operate. Extrapolate those results to current conditions on Earth.

The point is that unless the people who pay the bills see a clear and tangible return for their dollars, they will not support a space program, no matter how noble and stirring the true believers see it. What may be "important" to the proponents of space exploration may be worthless to the vast majority of our citizens.

My two suggestions are probably not the only ones that can be sold to the public, if the right emphasis is made. But they are unlike the Grand Design of the L5 colony, which to the public will cost hundreds of billions for dubious returns; and the SPS, which even if not linked with L5 would have to prove itself against a lot of competing technologies and would have to demonstrate its environmental safety to a variety of ultra-harsh critics. But any proposal that would require public support would have to show the public some tangible return that would not have been developed save for the space effort.

Unless that sort of approach is taken—unless the proponents of space are willing and able to talk in terms that the public is willing to accept—the space program will die, finally: not with a bang, nor a whimper, but with a wistful sigh. ■

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PARADISE MISPLACED

IAN STEWART

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The police are often asked
to find missing persons. Larger problems,
like missing islands,
may require the services of a joat.

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"Expect me back in about three hours, Belphoebe," said Billy the joat to his front door. In fact the door was an Inflex-screen thruport and he was addressing the domestic computer of his new villa, purchased from the profits of the NOSE-Holding Company. He had recently discovered, and become mildly obsessed with, Spenser's *Faerie Queene*.

Whistling merrily, he stepped past a grove of cultivated bogwhort, only to halt at the unmistakable sound of an approaching tove: a sonorous, flatulent gurgling like a marsh wollagong suffering from diarrhea. Assorted squelches and high-frequency hisses signalled to the trained ear that the vehicle was approaching at top speed. Repressing an urge to head rapidly in the opposite direction, he ambled over to the end of the jetty, arriving just as the tove oozed into the mooring-bay. A smartly uniformed SpaDe flunky draped the mooring-loop efficently over what he took to be a somewhat besmirched bollard. The supposed bollard, a dozing mudlark, uttered a startled *squonk!*, shot off the jetty like a scalded skunk, and hit the slime beneath like a beautician applying a mudpack to her mother-in-law. The flunky eyed his uniformed shirtfront dolefully.

Without a word, the joat attached the loop to the correct mooring-point. A Grynth official in full SpaDe regalia stepped deftly ashore. Recognizing him, the joat made greeting:

"Why, Archimago, luckless syre,
What doe I see? What hard mishap is this,
That hath thee hither brought to . . ."

The official eyed him sourly. "Mr. Jarneyvore, ordinary prose will suffice."

Palgandra, thought the joat, *has lost his sense of humor today. Though it takes an expert to notice. I smell trouble*. And belatedly he began to question the wisdom of some improvements he had made, with electronic assistance, to the previous week's video broadcast "What the Civil Service has contributed to Quaternity relations." Perhaps he should have consulted the video company about them first. On second thoughts, perhaps not. His remote digital-edit device had performed very well, though, in the circumstances . . .

Palgandra stepped gingerly across the thin layer of slime that coated the jetty. It was still wet, and caution on wet mud was a reflex on Grover's World. Billy tried a more respectful tack.

"Mr. Palgandra, I'm delighted that you should honour me with your presence. Is it a social call, or is there some pressing matter of state. . . ?"

"I would prefer," said Palgandra, "to discuss it with you in the privacy of your villa."

Reluctantly, Billy led the way. He had a brief but acerbic argument with Belphoebe, explaining that he had changed his plans and returned ahead of time and, dammit, couldn't the stupid thing recognize his voice like it was supposed to and let him in? Which, after some curious internal squawks, it did. Silently cursing Quaternity surplus vocoders, the joat led the way to a reception-room.

"Mr. Jarneyvore," said Palgandra, "have you ever visited Bahamba Bright?"

Relieved that it was not the Civil Service broadcast that had brought the Grynth to his door, Billy pursed his lips.

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"The resort world? Over in Pirelli sector." The Grynth inclined his head in confirmation. Billy was amused. "I admit our financial status has improved since the NOSE-Holding Company came into being—but you need a private space yacht even to get near the place."

The Grynth exhaled a snort through the two orifices behind the lobes of his ears—a slightly assent and disgust. He reached inside his cloak and withdrew a small metallic box, studded down one edge with a row of touchpads. He pressed one, and a vivid three-dimensional representation of a planet sprang into being in the air above.

It was a watery world. Tiny green islands were scattered in loose archipelagos across a turquoise ocean that enfolded the entire globe, beneath a sky flecked with wisps of woolly cloud in shades of salmon pink and lemon. It looked lovely.

"There are over seventy thousand islands in Bahamba Bright," stated Palgandra. "They are rented to wealthy visitors for relaxation, vacations, and the like."

"The exact number was seventy-two thousand, one hundred, and seven."

Billy caught the inflection. "Was?"

"The latest count is seventy-two thousand, one hundred, and six."

"They've lost an *island*?"

"A small one," said Palgandra hastily. "Half a kilometer across."

"How? Quake?"

Palgandra inhaled a snort of dissent. "Definitely not. Bahamba Bright has a tectonic stability index of 97. That's one of the reasons for its popularity. No, it would seem that the island has been forcibly removed. Hijacked."

"My word," said the joat. "That's an uncommon occurrence." The Grynth tried to snort both ways at once and nearly choked. Recovering, Palgandra touched more pads. A relief map formed.

"Part of the Riffe Archipelago," said the Grynth. "The four islands shown are Vnagar, Jaisalm, Strophny, and Trixydix." He pointed to each in turn. "This holo was taken two years ago in a satellite resource survey. Now—" he touched a pad "—this one was taken yesterday."

The joat looked at three islands and a patch of ocean. "No Trixydix," he said.

"Correct," said Palgandra. "The island has vanished."

The joat considered this information. "Any traces?"

"The locals report hearing a thunderclap and feeling a bit of a breeze; the marine seismologists have traces of small tidal waves emanating from a focus centered on Trixydix's coordinates. Nobody saw anything: it was dark. That's all."

"Great," said the joat. "Someone chanted the magic words, and the island paradise of Trixydix vanished forever beneath the surging ocean in a clap of thunder."

"Not only the island," said Palgandra. "The residents, too." He ticked them off on the digits of one leathery hand. "Turpine Carleson, a human industrialist. Jerz ap-Browan, Barasshanti cloud-sculptor. Luinda Rompstack, human video starlet. Llizllyllinzyll Jyrijjeer, Femmish philologist. Mykal Sarpent, Grynth ambassador to the Minor Drimp Cluster. Porgas Jurket, human numismatics dealer. Plus various

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items of robotic retinue.

"The Bahamba Bright Constabulary received a ransom note within one hour of the disappearance. It demanded one billion kroon per person, and stipulated that none would be released until all six ransoms had been paid."

"But all his mind is set on mucky pelfe," declaimed the joat,

"To hoord vp heapes of euill gotten masse,

For which he others wrongs, and wreckes himselfe . . ."

He broke off from his reverie. "That's quite a bundle of kroon."

"It is. It's *just* within the bounds of possibility for all, except perhaps Porgas Jurket . . ."

"Surely Rompstack wouldn't have that sort of cash!"

"Carleson has enough for two," said Palgandra drily. "But the availability of the money is immaterial. The Grynth would never be prepared to accede to such a demand on behalf of Mykal Sarpent."

"Why not? The Grynth Diplomatic Service is hardly poverty-stricken."

"It is a matter of principle. *Agneth* would be diminished."

The joat groaned. Ordinarily the Grynth were flexible pragmatists, except where that elusive quality was concerned. It translated loosely as "honor," or perhaps "face," but neither really captured it. On matters of *agneth*, the Grynth were as immoveable as a black hole event horizon.

Palgandra ignored him. "Naturally this is an unfortunate state of affairs. We urgently need to discover the kidnappers and recover the victims, *without* paying the ransom."

"Why are you involved in all this? What's the connection?"

The Grynth sighed. "The ambassador paid Grover's World a brief courtesy call immediately before his trip to Bahamba Bright. Because of a small misunderstanding on Aphélix, responsibility for his welfare was not transferred when he departed."

"Ah. The buck didn't get passed."

"Regrettably, no."

So now you want me to help pull the diplomatic hot potato out of the fire, thought Billy. *Oh no. Wyllam the joat is going to sit this one out and bone up on the* Faerie Queene. *And I don't care what fee they offer.* He looked at Palgandra. Palgandra smiled toothily.

"That, of course, is where you come in."

"An interesting notion," said the joat. "I am to be persuaded?"

Joze Palgandra waved his hands airily. "Why, Mr. Jarneyvore, it is common knowledge that one of your most positive attributes is a burning altruistic drive. I was saying to Chief Constable Pigge only this morning how refreshingly different that attitude was from that of certain other inhabitants of this planet. Why, only last week I witnessed an absolutely *disgraceful* exhibition of antisocial attitudes.

"Did you watch the programme on the contributions of the Civil Service to Quaternity relations?"

"I don't recall it," said the joat carefully.

"I'm glad to hear it, Mr. Jarneyvore. It would have shocked your sensibilities. Some irresponsible hooligan managed to tap a remote digital-edit device into the broadcast stream. It intercut

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clips from other sources, mixing the action from the clips into the original setting. We identified some of the clips with difficulty. One, I recall, was from *Nurse Sharegirls of the Asteroid Mine*. Another was from *Skin and Spacesuits*, a third from *Game Fishing in the Living Dead*. There were others, but I'm sure you get the general idea."

"Chief Pigge wasn't especially amused. He was threatening to send whoever was responsible to the Cyberian shockle mines. The maximum sentence, he told me, was ten years.

He had obtained an analysis of the techniques involved. They turn out to be sophisticated, and rather varied. Few Spectaxists would have the knowledge both to build the device and to circumvent the company's safeguards. It requires expertise in several fields. He thought that it was either the work of an organized gang, or a joat.

"Well, of course that reminded me of your good self. I put it to Pigge that it was really far more important to solve the Haxxdix case than to chase antisocial juveniles, and that by working in tandem with a joat he stood a very good chance of finding a solution. We had quite an argument, but in the end he agreed with me. However, he did stipulate that only the best joat in the sector would give him confidence enough to devote his time to the case. Failing that, he felt he would do better to hand the problem over to higher Quaternity echelons, and concentrate on more mundane matters like that shocking Civil Service broadcast.

I pointed out to Pigge that the best joat in the sector was Wyllam Jarneyvore. He said that his remark stood, nevertheless. On considering your past record, I told Pigge that I was certain you would be willing to aid him."

The joat gave the appearance of deep thought. "It's a difficult case, Mr. Palgandra," he said. "I would need extensive resources, and for offworld work I would need to charge all expenses *and* a higher fee than usual."

"That is no problem."

The joat held out his hand. "Mr. Palgandra, you're absolutely right. My sense of civic duty compels me to aid the admirable Chief Pigge in solving this dreadful crime."

The traveller approaches Bahamba Bright along one of sixteen space-lanes, corkscrewing in towards the equatorial plane at an inclination of some twenty degrees. Viewed from that angle, Bahamba Bright appears to be a ringed world, but, unlike that of Levanninna 6 or Old Saturn, its ring is not a natural formation. It is made up of space yachts, held in parking orbits: on average, a third of a million craft. This is a high traffic density for a non-administrative world, and all approaches and departures are orchestrated by Traffic Control, a sophisticated and powerful lateral processor of Femmish manufacture. Phasehopping is not permitted within the orbit of the Bahamban moonlet: the traveller rides the space-lanes on Standby Drive only. The planet has no large land-masses, and its solitary spaceport, Arcady, is reserved for a shuttle service which conveys visitors speedily and efficiently to the surface.

Wyllam Jarneyvore and Otis Pigge departed the orbiting *Shrimpton* and rode the shuttle down to Port Arcady.

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The Bahamban climate was near-perfect. Except in the polar regions, it was warmed by the brilliant white Bahamban sun to subtropical temperatures, low in humidity as a result of night-time showers, and fanned by gentle breezes wafting from island to island. A meticulously well-kept carriage, open to the sun and drawn by a pair of *skegga*, conveyed Pigge and Jarneyvore to the Lustrous Lagoon Hotel on Blue Mull. The Lustrous Lagoon was normally used as a transit stop for those with business at Port Arcady, being one of only a handful of hotels on Bahamba Bright. Most visitors were accommodated in individual island villas, each with its own stretch of beach, served by a fleet of hydrofoil taxis linking to a network of silent, high-speed flyers. The permanent population existed only to service the requirements of the wealthy tourists, and consisted largely of employees of *Agenzia Bahambin*, which owned the islands, the hydrofoils, the flyers, and Arcady Spaceport.

The clientele of Bahamba Bright sought not only peace and solitude, but also excitement and amusement, when they so chose. Each group of islands was furnished with a centrally located community area, or *pleasaunce*, furnished with parks, arcades, refreshment rooms, gaming halls, music, dancing, and other entertainments.

Pigge and Jarneyvore made contact with the local Constabulary, in the form of Chief Constable Lurkin Mole. Mole had amassed a large file on the hijacking of Trixydix and the kidnapping of its residents, but quantity was more in evidence than quality.

To all appearances, Trixydix had vanished off the face of Bahamba Bright. There were no traces of the method used to achieve this feat. Traffic Control reported no unauthorized vessels closer than parking orbit during the period preceding the disappearance. Seismograph records showed no signs of an explosion, although the island appeared to have been sheared off flat at the base, and residents of nearby islands had told of a loud noise like a thunderclap, and moderate tidal waves on the beaches.

"I assume the ransom demand, and the method of payment, opens no useful line of enquiry," said Pigge.

Mole confirmed that the transaction was in the hands of the Nomes. In the early days of the Quaternity it had proved essential to have an independent mediator between individuals and organizations, especially those of dubious legal standing. The wayfaring Nome communities had fulfilled this function admirably, and had diversified their activities in the succeeding centuries to an extent that was currently proving embarassing to QuatCent. It had repeatedly proved impossible to infiltrate the Nome communities, or to obtain useful information about their activities.

It then transpired that Mole had not, as yet, made a detailed inspection of the sea-bed where Trixydix had been. Pigge and Jarneyvore, who had already decided that Mole lacked initiative, requested him to make available an underwater inspection vessel on the following morning.

Then they took copies of the file back to the Lustrous Lagoon, and retired to their rooms to contemplate them.

Jerz ap-Browan. Barasshanti, off-

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spring of Browan ap-Nisr. Born Pearlseed IV, 280 QC. Protes- [illegible] Dead-sculptor. This trac- [illegible] Best-performed-actress-through- [illegible] administrator, [illegible] the heart- [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] watched by [illegible]

Jacomo Rompstack Carleson. Human- [illegible] Tycoon-at-Pesier Carleson [illegible] of the Pink Toad fastfood chain. After his father's death (from snakebite) further diversi- [illegible] into freight-handling, wrist computers, exotic jewellery. Born New Delphi, 296 QC. [illegible]

Georgia Shatrin Subhad Jurkei. Hu- [illegible] daughter of Mil'cent Subhad Kshatra. Born Lamnai Dreft, 27[illegible] QC. Dealer in rare [illegible] com. Convicted of speeding [illegible] restricted zone, Blyssom Gos- [illegible] area, 292 QC. [illegible]

Dorothea "Dot" Jeffries. Feminist, born Palamagantra-Tish, c. 252 QC. Ancestry unknown. Physicist specializing in [illegible] tile and proton [illegible]

Lamda Rompstack. Human, [illegible] Lettie Jane Rollop, daughter of Sydney Martin Rollop, born Bron- [illegible] VIIIb, 302 QC. [illegible] age 7, employed as checking clerk [illegible] Toad Foods Inc., Wem- [illegible] Metropolitan VI. [illegible] Rock-and-Roll, embarked on a video [illegible] career of throb songs [illegible]

Hakim Nasrin. [illegible] Girynth, son of Marcus Shump and Jucille Sar- [illegible] pent, diplomatic officials. . . Born third satellite, Gamma Lambar- [illegible] II, 264 QC. . . Appointed Ambassador to Minor Drimp Clus- [illegible]. Winchwood sector, 324 [illegible]. Lightsail racing enthusi- [illegible], qualified for Fomalhaut Chal- [illegible] Cup, 322 QC. . .

Within twenty minutes Billy the joat had memorized the file from cover to cover. Apart from the obvious pattern linking Carleson and Rompstack, there was nothing to go on. If the choice of island had been arbitrary, as was quite likely, the information on the victims was not going to help much.

The motive was wide open. The obvious—money—could cast suspicion on practically every citizen of the Quaternity. The only person the joat could safely rule out at this stage was himself, and that had nothing to do with possible motive.

The most promising line of attack was the *modus operandi*: specifically, the level and type of technology involved in a vanishing act with an island. But that was less than encouraging, if only because no such technology was known to exist. . . .

Anyway, before he could get far on that, he would need to inspect the site himself.

He wandered down to the hotel lobby. There ought to be better things to do on Bahamba Bright than beat one's brains out. Two girls in sunsuits sauntered past the entrance. Billy made his unhurried way down the steps towards the street.

Otis Pigge, who had been observing anxiously from behind a potted whyrtle

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plant, made a discreet exit and headed in the same general direction.

For several hours the joat sampled the offerings of Arcady pleasaunce: the surface gaiety of the brightly-lit arcades, the sweaty excitement of the gaming-rooms, the hubbub of the taverns as the holidaymakers flitted from one glittering spectacle to the next. *Agenzia Bahambin* was a moneyspinner, no doubt about that. The joat made a mental note: find out who owned *Agenzia Bahambin*.

Late evening found him in a quieter part of the pleasaunce, a grassy knoll overlooking Ambergray Park. He was about to get up and return to the Lustrous Lagoon Hotel, when he heard a footfall behind him.

It was a girl. A strikingly pretty girl in a filmy red dress. "Hello," she said. "I'm Lindilu."

The joat said the first thing that came into his mind.

"He had a faire companion of his way,
A goodly lady clad in scarlot red,
Purfled with gold and pearle of rich assay,
And—"

"That's nice. What is it?"

"It's part of an old poem, the *Faerie Queene*," said the joat.

"You're sweet. Who are you?"

"Wyllam Jarneyvore. Often known as Billy the joat."

She asked him what a joat was. Billy described the etymology, from "jack-of-all-trades," and the strange combination of abilities that a joat must possess. In return she told him a little about herself: Lindilu Glynde, daughter of a merchant of refrigeration equipment, vacationing on Bahamba Bright. Billy told her of Grover's World, with its endless mud seas and giant orange sun; Lindilu told him about her home planet of Hosperlan, where the Five Green Stars blazed in the dawn sky, and the flocks of *whydah* and *honeyfowl* glided above the Sarsheen fenlands at the turning of the seasons. Together they watched the glowing Bahamban sun descend beyond the horizon, between the towering *calyptus* trees that ringed Ambergray Park. And when they left the park, it was only natural that they should leave together. . . .

Otis Pigge had a less successful evening. Like the joat, he had become bored with the Trixydix file. Unlike the joat, he had read very little of it, although he had spent a similar time skimming through it, and come to the same conclusions regarding its likely value. He had nevertheless hoped to impress the joat with his diligence by claiming to have spent the evening in the hotel, and for this reason had taken steps to avoid being seen.

But Pigge's main reason for leaving the hotel was that he wanted to buy a souvenir. Something simple, elegant, and unmistakeably Bahamban in origin. Something that he could display on his desk back on Grover's World. Something to make his subordinates' eyes pop out. It took him several hours to become convinced that there was nothing suitable within his price-range. Annoyed with himself, both for his failure and for succumbing to temptation to begin with, he wondered idly whether there was any way he could make a purchase out of their expenses. Still debating the point, he turned a corner and nearly stumbled over Billy the joat.

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Pigge beat a hasty retreat and peered round the corner. The joat's back was turned, and he had not noticed the unwary Chief Constable. He had acquired a lady friend (Pigge noted the joat's good taste with grudging approval) who was trying to decide whether to buy a miniature *skegga* carved and polished by hand from a piece of dark-grained eucalyptus wood. She had picked it up and was inspecting it closely. Presumably it was not to her taste, for she replaced it on the vendor's cloth, and the pair moved away.

At that moment Pigge was struck by a mixture of thoughts. Uppermost was a professional curiosity in the joat's companion, but a second thought underlay it. Pigge sidled over to the street vendor's stall. He pointed to the *skegga*. "How much?" After some brisk bargaining, Pigge paid up a sum of two thousand kroon, insisting on wrapping the carving himself, which he did with unusual care, avoiding touching the shiny surfaces. Then he returned to the Astrolog Lagoon. The *skegga* revealed several beautifully clear fingerprints which he dispatched for free analysis by Central Files on Xenobia. Then he made an entry on his expense sheet for two thousand kroon, collected his effects and set the *skegga* on the table where he could admire it. A knock at the door, got no response, and a card was posted. Awakening early, Pigge found a note from Chief Constable Jarneyvore. No answer. Pigge wondered if a tail could have kept the man under surveillance all night. He made an accurate guess, called for Soundfix, and headed for the jetty.

The limpid waters of the Mermynthine Sound slid past the hull of the survey vessel *Caliban* with a gentle sibilance. The sea teemed with gaudy tropical fish whose flickering fins diverted them from the submersible's path. Jarneyvore and Pigge observed the spectacle through the ship's transparent hull. The taciturn pilot concentrated on his controls.

Caliban edged across the sound towards the Riffe Archipelago. The joat studied a chart. Ahead and to the left was the island of Jaisalm, ten kilometres long, with four jutting sandbars making it look like warped bagpipes. To the right, Vnagar atoll with its circular lagoon. The vessel submerged and continued down the center of the channel dividing the two islands. Now Strophny Isle loomed dimly ahead. The pilot adjusted his course to shave the western promontory. Beyond, according to the chart, was Trixydix.

For the first time during the voyage, the pilot spoke. "You should see the bottom start rising any time now."

Constable and joat peered ahead and down. The rippled sand of the sea bed developed mottled patches of rock. They saw small outcrops, then larger ones. Beyond was a steepening incline. Further up the incline—

Nothing.

It was as if the island had been sliced by a horizontal knife. About ten metres below the surface, the rising slopes of rock and coral broke off abruptly; above was only the luminous undulation of the waves.

Caliban rose to the level of the break, and slowed.

"It's remarkably flat," said Billy. "An absolutely level, clean slice. That's

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hardly credible. Pilot, can you cruise slowly over the area, please?''

The artificial plateau beneath them was covered by a thin deposit of sand and seaborne detritus. The joat told the pilot to settle on the plateau, and began pulling on a mask and breathing-tank.

''I want a closer look. I'll be back in ten minutes.''

Leaving by the aft airlock, he swam a little to one side, drifting gradually down to the bottom. The deposit of sand swirled in turbid vortices as his feet touched the rock. Then he was kneeling on the flat surface. With one hand, he gently stroked the debris away, and peered closely.

Something just below the surface moved.

It had eyes. It was a face.

His own.

''My God,'' breathed the joat. ''Lurkin Mole said it was sheared off flat. But he didn't say it was *optically* flat! It's a perfect mirror!''

Well, almost, he corrected. It was like highly polished marble, but with a far higher reflectivity than he had ever seen in polished stone: the image was sharp, but slightly darkened and colored. There were numerous cracks and holes, exactly like mineral samples sliced by a diamond saw. Using a chisel wedged into one of the holes, Billy broke a piece off for later analysis.

Returning to the vessel he informed Pigge of his discovery.

''Even a technological ignoramus like myself,'' said Pigge, ''can see that's an important clue. Any ideas, Jarneyvore?''

''I don't know,'' said the joat. ''How can you slice a quarter of a square kilometre of solid rock to get an optically flat surface, *without* using explosives? It's difficult enough to conceive of *with* explosives . . . though I suppose a focussed blast of dynoplax might get part way. Shaped annular charge, giving a planar dislocation wave . . . Not easy.''

''Mole should have discovered this,'' said Pigge.

''Lurkin Mole,'' said the pilot to their astonishment, ''lacks imagination.'' Then he opened up the throttle. ''We'd best be heading back, the air supply is getting low.''

Going back, the joat ignored the underwater scenery, and contemplated the puzzle of optically flat surfaces. He felt faint stirrings, deep in his subconscious. Somewhere before, he'd encountered such a phenomenon. But he knew the workings of his mind too well to dig for it. The seed would grow at its own rate: forcing it now might kill it altogether.

Lurkin Mole had a report from QuatCent. He flourished it at Billy. ''Here's a reply to your query about *Agenzia Bahambin,*'' he said. ''It took a devilish amount of prying to get what you wanted: it's an unquoted firm and there's nothing but bare bones on file in the Companies Register. I think the result will interest you.''

Agenzia Bahambin sported only ten shares. Four were held by the Cutche Combine, three by Imoth ap-Ost, and one each by Turion Plence, Savannah Holdings, and the Shill Corporation. The Cutche Combine was a wholly owned subsidiary of the Jeeling Astor Corporation, in which Pink Toad had a sixty percent holding. Imoth ap-Ost was not the name of a Barasshanti individual, as it seemed; it was a Baras-

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shanti shell company, owned by Nisp Chemicals. Nisp Chemicals was controlled by Jermyn ap-Browan, sibling of Jorg ap Browan. Turion Plence was [illegible] shareholder. His principal [illegible] but the rental of his luxurious [illegible] the Swoir Babbleeaty [illegible] Gothica Satpent, wife of [illegible] Savannah Holdings [illegible] network of small companies [illegible] Famish concern in the [illegible] of the Jyrtuc Cat. [illegible] Corporation was a complex list [illegible] maior event was [illegible] owned P. [illegible] gas [illegible]

[illegible] said Piggott. "It looks [illegible] somebody sabotaged the Agenda [illegible] Annual General Meeting."

"[illegible] perplexing," said Larkin. "We should have been informed [illegible]."

"[illegible]?" the joat's eye. Neither [illegible] his thought, which was [illegible] both. *Agenzia Bahamiya* had [illegible] anyone to know.

Lindilu Glynde was waiting, as arranged.

"Here," said the joat, taking her hand. She smiled, a trifle smugly, he thought, drew a deep breath, and recited

> *"But welcome now my lord, in wele or woe*
> *Whose presence I haue lackt too long a day,*
> *And fie on fortune—"*

"Book I, Canto VIII, verse 43," said Billy. "I see I'm not the only one with literary inclinations."

"It intrigued me," said Lindilu, "so I got a copy from the Library Computer. That's an amazing memory you have."

"Never forget a thing. Joat's Curse."

She bit her lower lip. "Yes, I suppose it can be."

"Bane of the profession," said Billy. "Mind you, some things are worth remembering."

The joat ordered food, and a carafe of *quitone*, a delicately scented wine imported from one of the hub worlds. They sipped it from tall glasses with helical stems as they ate.

"Any progress on the vanishing island, Billy?" He had told her a little of his business on Bahamba Bright.

"I fear not. The island's been sliced away, smooth as a mirror. It *is* a mirror: the analysts say it's just sheared, natural rock."

She shook her head in wonderment, and her hair danced. "That's weird. Any idea how it was done?"

> *"The sea itself doest thou not plainely see*
> *Encroch vppon the land there vnder thee?*

No more idea than the poet."

She drained her glass. The joat refilled it . . . and froze, as if stricken with a sudden paralysis.

"Billy! What's wrong?"

"Nothing. I've just had the glimmering of an idea. Let's see . . . how does it go on? A verse about throwing down the mountains; then it runs,

> *"Of things vnseene how canst thou deeme aright,*
> *Then answered the righteous Artegall,*
> *Sith thou misdeem'st so much of things in sight?*
> *What though the sea with waues continuall*

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Doe eat the earth, it is no more at all,
Ne is the earth the lesse, or loseth ought,
For whatsoeuer from one place doth fall,
Is with the tide vnto an other brought;
For there is nothing lost, that may be found, if sought.''

''I don't understand.''

''Neither do I,'' said the joat, ''but I recognise a hunch. My subconscious is trying to tell me something. 'Ne is the earth the lesse . . .', 'For there is nothing lost, that may be found, if sought . . .', 'Of things vnseene how canst thou deeme aright . . .'. And an optically flat boundary . . .

''Do you realise the energy needed to remove a whole island from this planet's gravity-well? It's enormous. You'd expect to detect a power-source for anything like that. Which argues that the island is still around, in some sense . . . somewhere . . . concealed. But by what? In what? Behind . . . no, beyond. *Beyond!* Beyond a boundary plane so flat you get reflections off the surface!''

''That's ridiculous, Billy. You can't conceal an island with mirrors! You've had too much *quitone*. Let's go to the beach for some fresh air.''

''No. Wait. I'm beginning to see what it has to be. Cleavage planes of a crystal lattice . . . no, that's silly, the rock isn't a uniform crystal. But it's something like that. Dislocations . . . spatial dislocations across a plane interface!''

Lindilu grasped his elbow. ''Too much wine, like I said. Perhaps I can think of a way to sober you up. . . .''

But the joat was transfixed.

''A transfer plane,'' he said. ''Someone's managed to make an interphase transfer plane work! The textbooks all say it can't be done, but I've never thought the proof was really watertight because it assumes the truth of Warhorn's Conjecture in fractional dimensions, and it's only been proved for algebraic irrationals . . .''

Lindilu retreated under the onslaught. The joat thumped the table with his fist. ''That's *got* to be it!''

''Billy, what's an interphase transfer plane?''

The joat picked up two chopsticks, laid them side by side on the tablecloth. ''Imagine these are two planes in space,'' he said. ''Not necessarily infinite; they can have boundaries if you want—in fact they have to for finite energy consumption. Now, what the interphase transfer does is kind of slit space down these planes and glue it up all wrong. It joins the left side of one slit to the right side of the other one, so you get a kind of crossover effect. Anything entering across one plane emerges from the other one. It doesn't take any time to do it, it just jumps, like a phasehopper.''

''I *think* I follow that.''

''I only thought of it because there are some standard calculations included as exercises in the phasehop manuals—it falls in the same theoretical area as spacecraft drives. The end point is to show that it's not possible, but along the way you have to show that *if* it can be done, then the planes have to be *exactly* flat. That's an easy consequence of the symmetries of discontinuous so-

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lutions to the Pindore-Maxwell Equations.

"You're getting technical again. Why does this give us a mirror?"

"Nothing to it. Suppose you set up a transfer plane across the base of Trixydix, connected to another one under the ocean somewhere else. Once it's switched on, Trixydix ends where the plane occurs, and above it is just ocean. The cut takes place along the plane, which is optically flat. The sheared rock-water interface acts as a mirror; but the rest of it is water-water and you don't see anything peculiar."

"That's all very well," said Lindilu, "but won't you get the top half hovering in mid-ocean over the other plane?"

"Smart girl. But it's going to be a more complicated set-up than just one plane. I'd guess they used a box, with transfer planes for sides. Put a box round Trixydix; put another box round an empty piece of ocean. Cross-connect, and presto! No island. Not in its usual place, anyway. Naturally, you have to make sure nobody can spot it in the *other* box, but that's just a secondary complication."

"Oh."

"There are two difficulties, though," said Billy.

"Only two?"

"I'll ignore the problem of *making* the transfer planes," said the joat expansively. "But it's pretty clear somebody knows how. No, my problems have to do with putting things back where they were. First, I don't know of any way to *detect* a transfer plane as such; you can only infer its presence from the discontinuities. Second, I have no idea how to shut one down from the outside—so to speak." He slapped the table again. "But there must be ways to get round those, and set the *Agenzia Bahambin* AGM rolling again." A peculiar look flashed across Lindilu's features, but the joat missed it, looking for the waiter. "Come on, Lindilu! You're right, I need some fresh air to clear my head!"

Billy the joat left Lindilu Glynde's holiday villa just before dawn. He boarded a hydrofoil taxi to the Lustrous Lagoon's private quay. At that hour, the quay was deserted. The joat touched a pad to summon the elevator. His head awhirl with Lindilu and transfer plane physics, he failed to hear the gravel crunch behind him. But even the scientific absorption of a lovestruck joat is no match for the pressure of a laser-pistol muzzle at the base of the spine. However, his befogged brain failed to recognise it as a threat. Instead, the joat swung round to identify the intrusion. His assailant had not expected this reaction: in the time it took him to decide to press the trigger, the joat had come fully awake, seen the weapon, and chopped at his attacker's wrist. The pistol dropped to the ground. With no time to pick it up, the joat kicked it into the sea, and moved so that his back was protected by a wall.

The man recovered from the blow and closed in warily. The quay was empty and the joat wasted no time in crying out. He rose on to his toes, preparing to dodge: mentally he flipped the pages of a *hai-ganzai* manual he had once borrowed from the library.

The man pulled out a knife. The joat aimed a *shika* kick at his groin. The

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assailant slashed at Billy's foot and missed, but deflected the kick: the knife flashed down in a swift arc. The joat blocked it with his arm; heard cloth rip and felt a sharp pain as the blade sliced his forearm. He lashed out blindly with his fist, feeling bone crunch; staggered as his feet were swept from beneath him and fell on his side. The raised knife gleamed, began to descend . . .

There was a brilliant flash of blue light that threw the nearby scenery into sharp relief, and a crackling sound like an electrical discharge. The knife dropped from a lifeless hand, and the assailant's body slumped to the ground.

Otis Pigge stuffed the laser pistol back into his belt. "Are you all right, Jarneyvore?"

The joat sat up against the wall. "A cut arm. Not sure how bad. Bloody." The light had increased enough for Pigge to take a quick look. The wound was deep, but the cut had missed the main arteries. Expertly he bound it with a strip torn from his shirtsleeve. "We'd best get you to a doctor," said Pigge, "and tell Lurkin Mole to pick up a body."

As the escalator rose, Billy asked what had brought Pigge to the quayside.

"Keeping an eye on you."

"Why? Don't you trust me?"

"Depends what about. Crime implies criminals. Criminals do not take kindly to investigators, especially in multibillion kroon kidnap cases. It would be to their advantage to discover what the investigators were up to. So when Billy the joat acquired a beautiful lady friend—"

"Damn you, Pigge."

"—I took the precaution to slap a tracer on him. And when he told the lady how the crime was committed, I began to fear for his safety. I guessed you'd come this way, but the quay looked safe and that fellow caught me on the hop. I *think* he was hiding beneath the quay. Moved like a squirt-snake: never saw him till he grabbed you. Lucky I got a clear shot at him: for a while I thought I wouldn't get the chance."

"Thanks anyway. But I'm not a *total* idiot. I checked Lindilu out myself through Immigration. Had the same thought you did. But she's genuine. How can you be sure she set me up?"

"I can't . . . yet."

"But—"

"But there's a corpse on the quay that was meant to be yours.

"And Immigration only knows what somebody else tells it. Your young lady's real name is Alaya de Flore Strooghn."

"That proves nothing," said the joat. "Lots of wealthy people like to travel incognito."

"And the Strooghn family used to *own* this planet. There are rumors of her great grandfather losing it in a private war."

The joat laughed bitterly.

"No wound, which warlike hand of enemy
Inflicts with dint of sword, so sore doth light,
As doth the poysnous sting, which infamy
Infixeth in the name of noble wight:
For by no art, or any leaches might
It euer can recured be againe;
Ne all the skill, which that immortall spright

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Of Podalyrius did in it retaine,
Can remedy such hurts: such hurts
are hellish paine.''

Figge looked at him, said gently: ''You're taking it pretty well, Jarneyvore.''

Shit,'' said the joat. ''I've never taken anything so badly in my life.''

''It's hard to accept that hypothesis, Mr Jarneyvore,'' said the SpaDe technical consultant. ''Especially from a non-member of a professional Guild. You invoke a device that all the textbooks say is impossible, and you admit yourself that there is no way to detect it in action.''

The joat's arm had been repaired with a reabsorbent bioglue and, while still painful, could be used. Billy leaned his chin on his hand. ''I imagine the textbooks would say that it's impossible for an island to vanish, Dr. Kmarsk.''

''That, I will concede.''

''Despite the absence of so-called *qualifications*, you may rest assured that I am competent, not only to *use* the Pindore-Maxwell equations, but to question some common misapprehensions about their solutions. *And* I don't need to thumb through the manuals: they're all right here in my head.''

Kmarsk objected. ''It's not just a matter of memory, Mr Jarneyvore.''

Damn right! But not only do I *understand* the material better than most Specialists do, I *know what else it relates*.

Such as Warhorn's Conjecture.''

It occurred to the joat that Kmarsk was giving up the contest without a fight. He had just advanced the joat's own best argument.

''That's part of it, yes.''

''I admit,'' said Kmarsk, ''that I had never realized the standard analyses made improper use of it. I spent half of yesterday in a huddle with the Library before I was fully convinced. And I'll also admit I was impressed. It's not often I get taught something new about phasehop theory by an amateur.''

The joat let that pass.

''So your theory,'' said Kmarsk briskly, ''is that the conjecture is false, the proof's fallacious, and somebody has found a way to set up a transfer plane.''

''You place too much faith in your equations, even now. The island has vanished. A transfer plane is the only explanation I can think of for that mirror-finish. It's the only explanation for the absence of any detectable disturbance. It fits. Personally, if the proof had been *correct* I would still have said it was a transfer plane. The Pindore-Maxwell equations would be wrong.''

The consultant inclined his head. ''I suspect you are right. Not all Specialists are as unimaginative as you seem to think. I would hope, at any rate, that the best ones are not. Let's assume you are right, and ignore the problem of detecting the thing. Do you have any idea how to shut it off?''

''Last night I didn't,'' said the joat, ''but I've been running a few calculations and I think it's obvious. It takes energy to transfer matter or radiation across the interfaces. If we shove enough stuff through, we should be able to overload it.''

''And you want me to recommend a military bombardment.''

The joat nodded.

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"So we ferry a cruiser in. On a hunch."

"Yes," said Billy.

"No."

"It's a good hunch. That's what joats are paid for."

Kmarsk's inclinations were to agree with the joat. The explanation did hang together. If you could accept the assumptions. For someone whose whole training had denied them, and got tangible results by so doing, that was hard. Especially when his career might depend on the outcome. The SpaDe top brass hated wasting ammunition.

"Give me one piece of hard evidence," said Kmarsk. "Just *one*, to justify it, and I'll stick my neck out. But not on a bald hunch."

The joat tried to think. "OK, let's run through the mechanism. They set up a box round the island; then another box round some empty ocean. Then they swap them."

"Fine," said Kmarsk. "How do they hide the island once it's moved?"

"Gimmick the screens with a different cross-connection, to kind of punch the second hole out."

Kmarsk pounced. "But wouldn't that distort the local metric?"

"I suppose so."

"Which means gravitational anomalies."

"Yes."

"Let's do a planetary gravity-scan."

To perform a gravity-scan they required access to the resources satellite, which in turn required access to Traffic Control. This was well within Kmarsk's powers to arrange, and after a longish session with the system manuals they fed the scanning program into the satellite. While they were waiting for some initial checks, to ensure proper functioning, the joat idly thumbed the pages of the Traffic Control manuals. It was the first, and probably the last, chance he'd had to see how such a system worked: and the innate curiosity of a joat is to that of a cat as a microprocessor to an abacus.

The joat read the manual, and was not impressed. The programs lacked imagination.

Otis Pigge called them. The body of Billy the joat's assailant had been identified as that of one Hymeth Ibral Fasmet, an inhabitant of Poor Yorick, a planetoid in the Shemplery system. Fasmet's holiday villa had been searched, revealing a small arsenal of weapons but no documents. Microscopic analysis of the dust on his clothes disclosed some unusual grains of pollen, found on only one cluster of islands on Bahamba Bright. When the minions of Lurkin Mole searched the villas in that region, they found one that appeared to have been vacated in a hurry. The villa had been rented to Lindilu Glynde.

The joat's mood was scarcely worsened when the gravity-scan failed to show any signs of anomalies. But his natural reaction to emotional stress was to concentrate harder on surface activities, to keep his mind off the painful topic. After half an hour or so of bootless argument, inspiration struck.

"Hang on," said the joat. "I've been assuming the second box was on planet, because of the need to match potential energy across the interface. But there are other ways to get the gravitational fields in close agreement. Maybe the

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second box is off-planet."

"But," said Kmarsk, "the theoretical range of a transfer plane is about a third of a light year. Where else would you find the right potential? The only other bodies in this system all have lower surface gravity than Bahamba Bright."

"No they don't," said Billy.

"Oh. The sun."

"Precisely. Kmarsk, you're a genius. Yes. I see it all now."

"Tell me," said Kmarsk.

"It's a three-way set-up. You need two boxes. One around Trixydix; one near the sun at the same potential. You identify opposite inside faces of the Trixydix box to shut the island up inside a self-contained universe. Anything trying to go out through a face comes back in again through the opposite face. It's a flat torus, in fact. Nothing gets out.

"Then you glue the inside of the box near the sun to the place where the Trixydix box's inside was. That way you don't get any gravitational anomalies on Bahamba Bright.

"But that leaves a hole in space near the sun, because you've lost the inside of the sun box. The easiest way to get rid of that is to identify opposite faces, from outside. So you just hop right across. That does create anomalies, but not in a place anyone would look for them."

Kmarsk interrupted. "You've lost me."

"Oh, sorry. Leave out the technicalities. You pinch off Trixydix in a self-contained universe; plug the gap with a bit of sunward vacuum so nobody notices; plug *that* gap by gluing its edges together. Then Trixydix disappears, and the rest looks much as it did before."

"What about the vacuum?" said Kmarsk.

"Well," said the joat, "when the switch is first made, you get an *empty* box down here on Bahamba Bright. But then the water and air flow in to fill it."

"Which means," said Kmarsk, "that you generate some atmospheric and hydrodynamic oscillations."

"Thunderclaps and tidal waves."

"I'll buy it," said Kmarsk.

A SpaDe Q-class battlecruiser descended on the Mermynthine Sound in the early afternoon of the following day.

The objective was to produce the maximum possible flux of energy, or of momentum, across the conjectured boundaries of the transfer plane box. A lasercannon barrage would do this admirably, but it would also be likely to boil the seas nearby. The ship's Commander suggested using blank Manticorium projectiles: essentially solid lumps of superdense metal. They plotted firepaths that would remain safe during the few seconds needed to shut down the projectors, after Trixydix reappeared.

Since it would be inconvenient to have the island return in darkness, the bombardment commenced at dawn: an ancient military tradition much to Commander Macintyre's taste. For an hour the massive projectiles ripped across the skies accompanied by earsplitting sonic booms. Two hours. Three.

Kmarsk expressed the hope that Jarneyvore's hunch would hold up under fire. The joat reaffirmed his confidence: the makers of the transfer plane had

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merely incorporated a large energy capacity. But, as the end of the fifth hour approached, even he began to have doubts. The battlecruiser had expended profligate quantities of expensive Mantecorian projectiles like a mudlark with a nest of sumps ugs, and still the planes held. How many planes there were.

There was an almost subliminal discontinuity: the bombardment ceased.

Trixydix had returned.

There were no tidal waves or thunderclaps this time: the water-levels and air pressures matched closely. Though presumably a part of the Mermynthine Source was now in solar orbit. Kmarsk and Honeyvore shook hands.

Lindilu Glynde, alias Alaya de Flore Strooghn, had been picked up at Aready Spaceport trying to hop a shuttle. Her hand baggage contained a baffling apparatus presumed to be the transfer plane generator. She had been arrested. Otis Pigge informed the joat, and handed over to the Constabulary: the device had gone to the Spa'De laboratory attached to Aready Spaceport, to be examined by a team headed by Kmarsk. The joat's presence was requested.

Lindilu arrested. The joat had expected to feel a certain grim satisfaction: the vengeance of the betrayed. He didn't. He felt empty.

"So it's all over bar the shouting," said the joat dully.

"I'm not sure," said Pigge.

"You aren't? But it's crystal clear!"

"You know," mused Pigge, "I've been a constable most of my life. Worked up from the ranks, and it wasn't easy. On the way I acquired a lot of indefinable things. Intuitions, you might say, though personally I don't hold with the word. I'd say it's a feeling for pattern. Now it's certainly true that this young lady of yours—"

"She damned well is *not!*"

"But you still wish she was. Oh, shut up. I'm talking. This young lady, Miss Strooghn, is certainly involved in some shady business. There's no reason to doubt that she, plus Fasmet, plus others unknown, made use of the transfer plane generator to hijack Trixydix and kidnap the principals of *Agenzia Bahambin*.

"But there are loose ends. And in my experience, loose ends are best tracked down to avoid possible injustices. One great big juicy loose end is *Agenzia Bahambin* itself. Why all the secrecy and subterfuge? Why conceal the fact that the kidnappees were all top frogs in *Agenzia Bahambin?*

"And another one: *what was the Strooghn woman's motive?* I don't believe for one moment that it was money. She's from a very wealthy family on Hosperlan; she doesn't need money. There's more to it than that.

"I'd lay a heavy bet that it has something to do with her great grandfather. I've been digging around in old records from the Companies Register." He handed the joat a wad of paper. "Here are copies. Bahamba Bright was originally discovered by a colonist called Durgash Strooghn. Alaya's ancestor. He sold it to *Agenzia Bahambin* for a peppercorn rent—which looks a trifle odd to me: it's much too valuable a property."

The joat digested this information. "And what do you propose to do about it?"

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Pigge pressed his fingertips together. "It seems to me I've done most of what I can already. What *I* intend to do is bask on the beaches in the Bahamban sunshine and pick up a healthy tan. The longer this case stays open, the happier I'll be.

"What *you* do is up to you. But if I were in your place, I'd consider ways of finding out from Miss Strooghn what she was really up to."

"You're crazy! She tried to have me killed! I'd rather leave her to rot!"

"She told Fasmet what you knew. Fasmet tried to kill you. He may have got that idea himself. There's no evidence that the Strooghn woman ordered it.

"Anyway," said Pigge, "if you *do* want to leave her to rot, you might be interested to know that she's rotting in cell 23, corridor 12, level 5 of the Shan Husan prison, here on Arcady. Here's a map." And he tucked it into the joat's tunic pocket.

The SpaDe laboratories were in a less than accessible corner of the Spaceport area, and security had been tightened. Kmarsk was working on the transfer plane generator with a neutrino spectrograph when the joat finally gained admission, and for the next few hours joat and consultant ran every test they could devise.

By the end, they could both work the machine perfectly, and they had no more insight into it than they had had to begin with. The peripheral components were comprehensible: positional locators, stabilizing circuits, energy sinks. But the heart of the mechanism was a tiny, sealed unit barely a centimeter across. Exotic waveforms emanated from the unit, but its internal structure proved inaccessible to everything from X-rays to quark diffractometry.

Kmarsk's determination to understand the device rendered him almost oblivious to everything else. So, while Kmarsk was making delicate adjustments to a Thom Transverter, the joat's dexterous fingers extracted the consultant's ID magcard from the side-pocket of his overalls. This Billy ran through a miniature magnetic scanning detector which he had built the previous evening and disguised as a calculator to get it past the security men. The magcard was then returned to its unsuspecting owner.

At noon the joat departed, ostensibly to get lunch. In Blue Mull market he purchased a Bahamban souvenir: a portable electronic *zuffoletta*, or flute-organ, in a calyptus wood case. He deposited this in his room at the Lustrous Lagoon and returned to the laboratory for a further afternoon's work.

In the evening, in the privacy of the hotel, he manufactured a duplicate of Kmarsk's magcard. With its aid, and some expert lockpicking, he penetrated the laboratory area soon after midnight, and stole the transfer plane generator.

Half an hour later he was huddled in undergrowth in the dense woodland that bordered the spaceport. By the light of a glowtorch he studied the map that Pigge had given him, changing the control settings on the machine to match the coordinates of Alaya de Flore Strooghn's cell in Shan Husan prison.

Alaya-Lindilu was asleep: the joat recognized the snore. An insistent whisper, directly into her ear, interrupted her

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dreams. *Lindilu! Wake up! Don't talk, don't move, whisper! Wake up!* It repeated in a hypnotic chant. She awoke. The conditioned pattern had set, and she made herself relax and lay still.

"Who's that?" she whispered faintly. "Where are you?"

"Yes."

"It's Billy."

"I can't see you!"

"I'm not there. I've opened up a small transfer plane link to talk through."

"And you'd better talk fast, Lindilu Glynde as was," and it had better be good."

She hesitated. "Why should I talk to you?"

"Because I might just decide to get you out of there."

It was a simple story.

Four generations before, the Strooghn family had discovered Bahamba Bright and begun to develop it as a colony world. Alaya's great grandfather, Durgash Strooghn, had employed as assistant a certain Dixon Purl. Purl had murdered Strooghn, but his wife and child had escaped. Documents in Purl's possession ceded to him the Strooghn family's rights to the planet in return for a nominal annual fee. The documents had been forgeries, but Clementine Strooghn had been too busy dodging Purl's hired assassins to make any protest through legal channels.

Purl had set up *Agenzia Bahambin* and started Bahamba Bright on its pleasure-planet track.

Clementine Strooghn had evaded pursuit, and settled on Hosperlan. The Strooghn genes asserted themselves, and the family acquired money and lands. Alaya's father had invented the transfer plane. Soon after, *Agenzia Bahambin* had finally tracked the Strooghns down, and he disappeared. Alaya had fled with her kin to Poor Yorick. There she had found a way to use the transfer plane generator to fight *Agenzia Bahambin*. The kidnap was the first step: it put pressure on the opposition, and provided additional finance. Enough pressure might win back the planet.

"It sounds a pretty amateur scheme," said Billy. "Too drawn out. Bahamba Bright makes an impressive power-base. Before you can get back the planet, you have to eliminate the power-base: that is, take the planet away from them. But if you can do *that* . . . Anyway, your plan was screwed up by the Grynth. *Agneth:* racial pride. They wouldn't pay."

"We tried what we could," said Alaya in a defeated tone.

"And then Pigge and I came along," whispered the joat, "and—"

"And we kept tabs on you."

"Very enjoyable tabs," said the joat bitterly. "They were part of the plan?"

"*No!* I didn't mean to—I wasn't intended to—damn it, Billy, I *liked* you. A lot!"

"So you told Hymeth Fasmet to kill me, when you found out I'd discovered the secret."

He heard a sharp intake of breath.

"*What?*"

"He attacked me with a knife. Pigge shot him."

"*Oh no. No.* Billy, I didn't know that! He said he was just going to take you out of circulation for a while, maybe get you off planet, until it was over. I would *never* have told him what

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you'd said if I'd known he was going to—to—you've *got* to believe me!"

The joat hesitated for a heartbeat.

"You damned amateur. When I found out that much, he *had* to kill me. It was me or you."

"Billy, suppose you'd known then that it *was* me . . . and why . . ." she paused, then said in a whisper so quiet he could barely hear, "*what would you have done?*"

"Why should I trust you?" said the joat, ignoring her question.

"Because I desperately need your help. And I *didn't* order you killed, I swear I didn't." The anguish in her voice sounded genuine. It could be an act—but the story fitted what else he knew. And the joat remembered that first, astonishing night. . . .

"All right," said Billy. "Let's assume I believe you. I'm probably a damn fool but I don't have the time to make certain. I'll back a hunch. But from now on, you do *exactly* what I tell you."

"Yes."

"And the answer to your question is: I would have told Lurkin Mole that I had no idea where his missing island had gone, or why."

Speed was essential.

Billy cut the transfer connection. He removed the generator from its cover, and placed the device inside the empty casing that had earlier housed the *zuffoletta*. He made a few spurious connections, enough to pass a casual inspection; then he headed for Arcady Spaceport departure lounge, collecting his baggage which had been sent from the hotel on his instructions. The excise man glanced inside the *zuffoletta* but was satisfied by the incomprehensible assembly of components. Ten minutes later Billy the joat was in parking orbit: an hour more and he was out of Traffic Control zone and the *Shrimpton* was ready to phaseshop.

The first hop took him to the far side of the Bahamban sun, at a radius making the gravitational potential roughly equal to that on the surface of Bahamba Bright. From there he hoped to open a transfer plane link between the yacht's cabin and Alaya-Lindilu's cell.

After a quarter of an hour he was forced to revise the plan. The planet's motion in orbit was too complex, and the distance too great, to be able to hold the plane steady enough.

Hastily improvising, the joat 'hopped back to the edge of the Traffic Control zone, in the shadow of Bahamba Bright's jagged, deserted moonlet. What he really wanted to do was open up a transfer plane to the planetary surface and drive the *Shrimpton* through it. But it would destabilize the generator to pass it through its own transfer plane; and he couldn't leave it in orbit because the controls needed manual adjustment.

Instead, he created a transfer plane box around the *Shrimpton*, linked to another one near the sun. Although the generator was inside its own box, it had not traversed a plane interface, so its stability was unaffected.

It was a tricky business, but a skilled pilot could just about succeed. The joat, using the generator's locality controls, lowered the box towards the surface of Bahamba Bright, keeping the *Shrimpton* inside it. Simultaneously he moved the second box towards the sun, to

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maintain equal gravity potential. From the outside—and in particular to Traffic Control—the *Shrimpton*'s box was empty, and attracted no attention: *Shrimpton* itself would have appeared to be moving into the sun, but Traffic Control had no interest in movements that far away. When the box got below Bahamban altitude roughly above the woods near Aready Spaceport, the joat switched off the generator. *Shrimpton* suddenly materialized above the Bahambin woods; the joat corrected its attitude and lowered it into a clearing. It was a complicated way to avoid being seen by Traffic Control, but it worked.

From his place of concealment among the trees, in the darkness, he had no difficulty in setting up a transfer plane link to Alaya's cell, big enough for her to step through into the *Shrimpton*'s cabin.

Then the joat reversed his box trick to lift it planet again into the moonlet's shadow, switched off the generator, and chased-up out of the system like a midnight pursued by a starving wolla-bat.

If Alaya had expected to be treated like a damsel in distress rescued by a knight errant, she was wrong. The joat interrogated her for some three hours on every aspect of her story: the past history of the Strooghns, the terms of the document (of which Pigge had given him a copy) that ceded their rights to *Agenzia Bahambin* for a nominal fee, her movements on Bahamba Bright . . .

At the end of it, her story still hung together.

"OK, Lindilu. I really *do* believe you now."

Alaya-Lindilu smiled wanly. She was drenched with sweat and the coarse prison clothes were clinging to her body; her hair was lank and greasy, and she was exhausted by the intensity of the joat's questioning. "You damned well should. You put me through the mangle."

"Sorry, Lindilu," said the joat. He touched her hand gently. "Mind if I still call you that?"

"No."

"I had to make certain."

"But you'd already rescued me. That alone could have got you into trouble."

The joat dismissed it. "Nonsense. *I wasn't even on the planet*, remember?"

Lindilu changed the subject. "I want to get out of these awful rough prison clothes."

"Sure," said the joat absently. "Now, as I see it, the next move will be to—Lindilu, what are you doing?"

"Getting out of these awful prison clothes. You said I could."

"Yes," said the joat, "but I *had* anticipated you putting something else on instead."

"Spoilsport. I don't mind."

"Ordinarily," said the joat, "I wouldn't mind either. But right now, I think we ought to make our next move. Here, you can have my shirt." He wriggled out of it. She took it from his hands, and started to undo his belt.

"Hey! You're supposed to put that on, not take off more of mine! What are you playing at?"

Lindilu gave him a wicked smile.

"I'm making my next move."

"Now, lecherous joat: what were you trying to tell me?" Lindilu had donned

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the shirt. The joat looked at her appreciatively, and began,

"Straunge lady in so straunge habiliment . . . "

"I recognize that bit," said Lindilu. "Una. Let me think . . . Ah, yes.

"Most vertuous virgin borne of heuenly berth,
That to redeeme thy woefull parents head,
From tyrans rage, and euer-dying dread,
Hast wandred through the world now long a day . . .

Quite apt; though I think you do have me a trifle miscast."

"That's not a bad memory you have, yourself," said the joat.

"No, and it's still reminding me about next moves. Give."

"It's nothing much. I just felt we had some unfinished business. How do you feel about trying to get Bahamba Bright back into Strooghn hands? Could you keep it?"

"If that's a joke, it's in precious poor taste."

"It's no joke."

"We could keep it, now. We've learned to play rough. But I thought you said that before we could take it away from them, we had to take it away from them. How do you propose to get round that?"

"Well," said the joat, "we've let the *Faerie Queene* call that tune several times already: I thought we might play this one by the book too.

". . . with ragged rift
Doth roll adowne the rocks, and fall with fearefull drift."

"Aha!" said Lindilu. "You're going to bomb Bahamba Bright with stray meteorites. An excellent idea, young man: you'll only kill a million or two and ruin the fair scenery."

"You're a bright girl," said the joat. "You're closer than you imagine."

Within twenty light years of Bahamba Bright lies the rimward end of Sharraby Breach, a vast rent in the fabric of spacetime, stretching from the edge of Pirelli Sector to the far side of neighbouring Lobačevski Sector. At each end of the Breach is a desolate wilderness of turbulent dust, interspersed with fragments of rock ranging in size up to small planetoids. Such regions are avoided by the wary, but the absence of observers can prove attractive to those of nefarious intent.

With phasehop drive and transfer plane, Billy the joat sneaked up on Sharraby Breach and swiped a planetoid.

In third-of-a-light-year jumps, he transferred it over towards the Bahamban system, 'hopping after it like a cosmic basketball-player. The final transfer plane took some time to adjust, because the plan called for high precision.

The joat pushed the button.

The asteroid rolled smoothly onward, met the transfer plane, and disappeared.

It emerged not far from Bahamba Bright, on a collison course with the moonlet. *Shrimpton* 'hopped up above the ecliptic to watch the fireworks.

Planetoid and moonlet impacted in a soundless explosion with the force of a neutrino bomb. White-hot magma seethed and spurted; expanded into a huge, smoky, glowing ball that writhed as if in torment. The combined mass, speeded on its path, imperceptibly changed its orbit.

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Big deal," said Lindilu. "You've blown up the moon. And now all the moonstruck lovers will boycott the planet and put *Agenzia Bahambin* out of business."

[illegible] faith. "I've given you [illegible] and while you're thinking [illegible] can rustle up some [illegible]."

[illegible] Control Zone ends at the moon's orbit. The only things out [illegible] Traffic Control knows are [illegible] bodies whose orbits are [illegible] by gravitons and such. Which is [illegible] I didn't just move the [illegible] into the ring. But, [illegible] programming [illegible] Traffic [illegible] responsibility of *Agenzia Bahambin* and [illegible] who read the manual, [illegible] some small

[illegible] that ancient contract." He thrust under her nose the copy that Pigge had given him. "Early Quaternity law is built like a brick outhouse. It would survive the Big Bang. If *Agenzia Bahambin* fails to pay that *nominal* fee, that peppercorn rent that they wrote in as a tiny deceptive touch of honesty, the contract becomes void. And then, by the Law of Heritable Seizin, ownership reverts to the descendants of Durgash Stroughton.

"Third, again under Quaternity Law, the assets of a bankrupt company are frozen. It can make *no* payments whatsoever."

"And now, wench," said the joat, patting her on the bottom, "lunch!" Feigning indignation, Lindilu swept out of the cabin.

Traffic Control shut down all approach lanes and ordered all travellers in transit to leave their yachts and take the shuttle back to Port Arcady. That was a routine precaution, and the joat had counted on it. "That will avoid anyone getting hurt," he remarked to Lindilu, between mouthfuls of roast velverduck.

"You're crazy. What's going to hurt them?"

"Keep watching."

Through the telescopic screen they could see the massed phalanx of private yachts, in parking orbit. After a time, Lindilu noticed a definite movement. Some of the yachts were shifting in orbit, jostling each other. Two collided and blew up. The fragments damaged others, the jostling became more violent. Elsewhere there were further explosions. Billy cut to a long distance shot.

Bahamba Bright's ring was on fire.

Lindilu looked at him. "We did *that*?"

"You weren't impressed when we blew up the moon," said the joat.

"I'm not impressed now—I'm horrified. But even I can see that if you bash a moon with a planetoid, something's going to blow. *This* I don't see."

"The mass, and orbit, of the moon has changed. That alters all the stability properties of orbits in the ring. You get new resonances that weren't there before; yachts start to oscillate around instead of sitting still. It doesn't take much disturbance to break the stable patterns.

"That's where *Agenzia Bahambin's* lousy programming comes in. They have a stability program, but the moon's orbital data are *wired* in. It never occurred to them that the orbit could

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change. Garbage in, garbage out: Traffic Control says it's stable, but Mother Nature says otherwise. Unfortunate for *Agenzia Bahambin,* who placed their belief in Traffic Control, without understanding how it worked.

"Of course the fault will be obvious enough *now*."

The joat looked at Lindilu like a mother wollagong waiting for its offspring to make its first leap into a mud-wallow. "Seems to me," she said, "that there are several hundred thousand tourists whose expensive space-yachts have been wrecked. They'll want blood."

"Right."

"Thanks to faults in Traffic Control, it will be *Agenzia Bahambin's* blood, in the form of legal damages. For the yachts, *and* the inconvenience . . . hang on, what if they're insured?"

"For *that?* Anyway, you can't insure against Acts of God."

"Stop bragging. So, *Agenzia Bahambin* goes bankrupt and loses its power-base to boot; the Quaternity freezes its assets; it can't pay the nominal fee; and we get our planet back."

"Exactly. We'd better get moving before SpaDe comes to investigate. Poor Yorick's the best bet, I'd say. Won't take more than a few minutes to set up for a phasehop."

"Oh."

He studied the indicators. "Woops. Something wrong. The phasefringe fuses have blown."

Lindilu didn't think she should mention that she had thrown them out of the garbage-port.

"That's funny," said the joat. "The spare fuses have vanished."

"You'll doubtless be telling me you've run out of fuel, next," said Lindilu. "You men are all the same." She'd thrown the spares out too.

"We'll have to find a nearby planet that we can reach on Standby," said the joat.

"That will take a bit longer, won't it?" asked Lindilu hopefully, as the joat interrogated the astrogation computer.

"Sure will," he said. He looked at the display. "Yes. Two days to Hector's Folly."

Lindilu looked disappointed. "Only two days?"

"Mind you," said the joat, "this is a SpaDe vessel based in Lobaĉevski Sector, so that will be Aphéligian Local Time."

"How long," asked Lindilu, "is an Aphéligian day in Quaternity Standard Old Earth Units?"

"Not sure," said the joat. "Let's find out." He pushed a few buttons. "Well, well. According to this, it comes to about twenty-two Standard Days."

"I hope you've got plenty of spare shirts," said Lindilu. ■

● Being a layman...is not a fatal handicap in the reassessment of what is happening to science and scientists. Indeed, in some ways it may be an advantage, for to a degree the future course of science depends on an understanding not of complex technical content but of science's basic purposes as an expresssion of a deep human need to know.

DAVID E. LILIENTHAL

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Jay Kay Klein's

BIOLOG

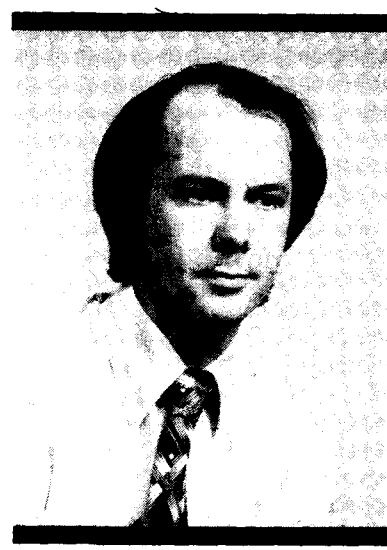
Born in England a few weeks after the world's first atomic bomb blast, Ian Stewart went on to become an authority on catastrophe theory, receiving an M.A. in mathematics from Cambridge University and a Ph.D. from the University of Warwick. A science fiction fan since fourteen, perhaps inevitably Ian first appeared in *Analog* with a science fact article on catastrophe in the June 1978 issue.

While on a visiting lectureship in Connecticut, he met *Analog*'s editor, who suggested he try fiction. The result was a first story published one year after the article, in the June 1979 issue. Other lectureships have taken him to New Zealand and Germany for one-year stays.

Textbooks on mathematics, articles in learned journals and popularizations for the layman occupy his free time, along with cartooning, surrealistic painting, guitar playing, theatrical scenery design, [illegible] playing cricket on the [illegible] and presiding as chairman [illegible].

At the moment, Ian is writing a novel [illegible] titled *The Vegetable Connec[illegible]*. His study walls are covered with [illegible] percent of which is de[illegible] science fiction. He feels that science fiction is one of the great literary developments of the twentieth century, formed by writers outside the straitjacket of the literary and academic establishment. His ideal science fiction is unpretentious, imaginative, entertaining, and has a core of hard truth.

Ian is currently a lecturer at the Mathematics Institute of the University of Warwick in Coventry, England. He expects to visit the United States again this summer at a Singularity Theory Conference.



Ian Stewart

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MARGARET L. SILBAR

AND NOW--SUPERGRAVITY!

THE LATEST ENTRY IN THE QUEST FOR A UNIFIED FIELD THEORY.

"He has made His forces extend through Earth and Water, Air and Heaven and left no part of the Universe destitute, and by uniting All with All has bound them fast with invisible bonds."

Philo Judaeus, 30 B.C–40 A.D.

The concept of force—the pushes and pulls of Nature—is as old as Aristotle, perhaps as old as language itself. It lies at the very heart of that science known as physics. When the young Isaac Newton showed how the *same* force is responsible for both the Earth's circling the Sun and the falling of an apple, modern-day physics can be said to have begun.

Since Newton's 17th-century *tour de force*, experimental discoveries have led us to extend the concept of force from the domain of everyday life to that of the very small. We now recognize three other fundamental forces besides gravity. Each of these is in its own way very important in our lives.

In the beginning, *gravitation* allowed the Earth to accrete from cosmic dust and today it holds down all the Earth's latter day accouterments, such as mountains and trees. Were it not for *electromagnetism*, atoms would not hold together and so the question of trees—and indeed life—would never have arisen. Without the *strong force*, there would be no element but hydrogen, and maybe even that wouldn't exist. Hydrogen atoms alone could never have provided the complicated chemistry necessary for life to emerge. Without the *weak force*, the Sun and stars could not generate energy, and life, even had some malevolent "Universe God" willed it into being, could not have persisted for even seconds.

All four fundamental forces we have discovered are thus essential to our very existence. They define the nature of matter, as we know it. But are these very diverse forces independent of one another, or are they linked and unified

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in some grand scheme wherein each implies and requires the other? Looking for Plato's "invisible bonds"—the common symmetries of the mathematical equations describing each force—is one of the challenges of today's physicists. Physicists hope eventually to bring the four forces together into one grand "Unified Field Theory." If and when that comes, galaxies, mountains, [illegible] protons, electrons, and [illegible] will be described in [illegible] physical picture.

[illegible] is to be expected, scientists [illegible] the same point in pursuing [illegible] directions. Some physicists are searching for ways to bring together the theories of the very small, hoping only later to incorporate gravity. Gravity is a force that we cannot so far explain in a fashion consistent with the quantum mechanical principles which formulate the descriptions of the other three.

Other physicists are seeking to begin with the enigmatic force of gravity. A rather recent version of this latter approach, one which has provoked a lot of activity among mathematical physicists, is called "Supergravity," and it is the topic of our tale. But, as we shall see, other kinds of unified theories for the other three forces also play a role in the telling, and we will have to go down many rosy garden paths before we can talk about supergravity itself.

Supergravity is more than just a description of how particles called "gravitons" mediate the force of gravity. It also predicts that gravitons have kid sisters called "gravitinos." Moreover, it may even be—as a consequence of the equations—that there exist, somewhere out there in the night, things which fall upward, rather than downward.

Gravity was the first force to be understood mathematically, and, as such, it became the ideal for latter-day mathematical theories. It also represents, as in our chart, the first unification ever of what were thought to be disparate forces in Nature: celestial and terrestrial gravity could be understood in terms of each other. That Newton even thought to ask—"Are the motions of projectiles on the Earth and the orbits of the planets similar?"—is a tribute to his genius.[1] In his "Principia," published in 1687, he gave us the so-called "inverse square law." The gravitational force, he said, acts universally between all pairs of objects with a strength directly proportional to the product of their masses and inversely proportional to the square of the distance between them.

Newton's Law of Gravity makes clear that while gravitation holds the solar system together and is the dominant force on the scale of the large, it is a negligible force in the elementary particle world. The gravitational force between the negatively-charged electron and positively-charged proton in a hydrogen atom is more than 10^{39} times weaker than the electrical force binding

[1] [illegible] even a question considered some 80 years earlier by Johannes Kepler, the man who first thought [illegible] into the celestial sphere.

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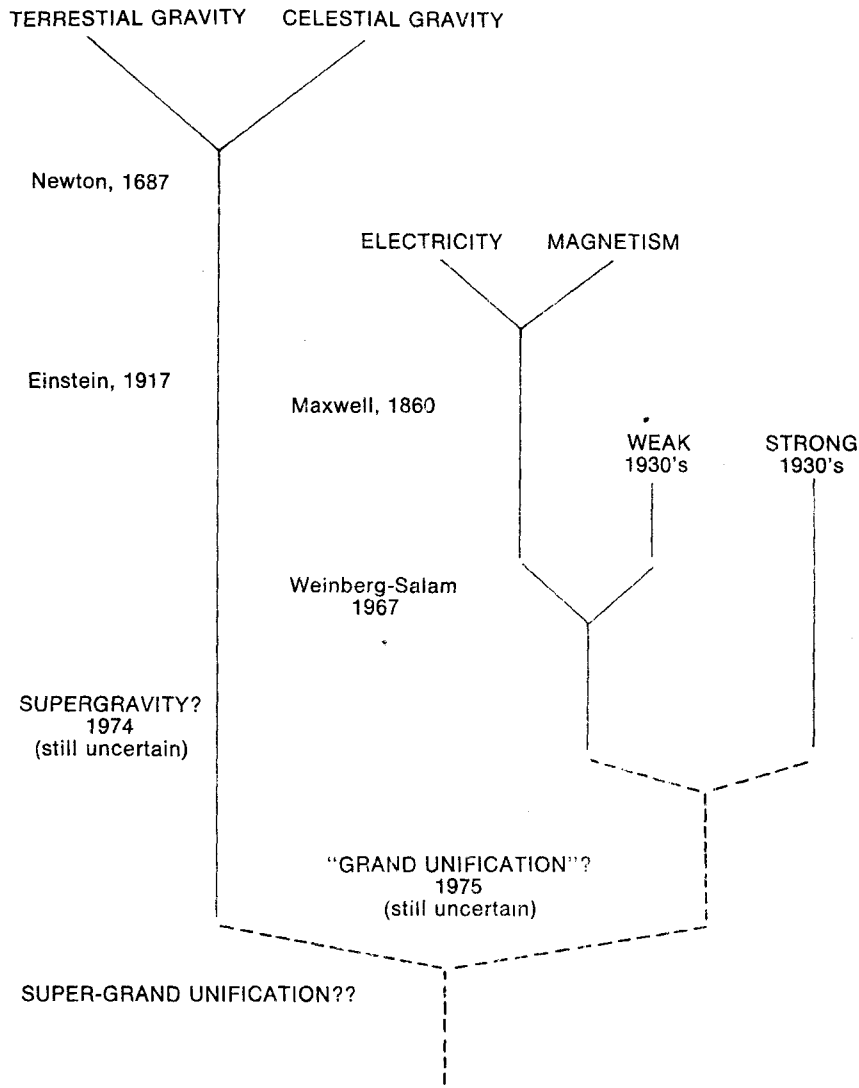

The flow of physics towards more and more unified theories.

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the two together. But we are racing ahead of our story.

Electromagnetism represents another unification equally as surprising to the physicists of the 19th century as was the law of universal gravitation to Newton's contemporaries. (Descartes probably never did get over his pique.) Under one mathematical umbrella, James Clerk Maxwell gathered together such very diverse forces, known since the time of the Greeks, as those between bits of feather and rubbed amber rods (this is electricity) and a lodestone and a piece of iron (this is magnetism).

At that time, a number of Maxwell's contemporaries were analyzing the forces between charged and magnetized bodies in considerable detail. While they publicly spoke of "lines of force" between charged particles, they had in mind that they essentially regarded the forces between the particles as invisible rubber bands. It was Maxwell's genius to capitalize immediately upon the slightly mystical views given these words by the great English experimentalist, Michael Faraday. Faraday had discovered experimentally that electricity and magnetism are two aspects of one phenomenon in the sense that changing conditions, each can induce the other. This finding caused Faraday to say: "Where is the *field* of force?"

This is a radical change of the concept of force as a function not between bodies but of the space and time between them. Maxwell incorporated into his now-famous equations this concept of a time-varying spatial field by which a force acts.

Heinrich Hertz, who demonstrated the truth of Maxwell's equations by discovering radio waves, said he thought of Maxwell's formulae as having "an independent existence and an intelligence of their own." Proof of this, he said, lies in that "we get more out of them than was originally put into them." True, indeed. For example, Maxwell did not think of his equations as contributing to the understanding of the science of optics—how light is refracted and reflected by lenses and mirrors—but in fact the equations do explain all of that.

As this century opened, most Natural Philosophers believed that the world and all that is in it could be described by just two forces—that of Newton's gravitation and Maxwell's electromagnetism. Albert Einstein is hardly to be faulted, then, for setting out to unify these two forces. He had earlier accounted for the experimentally-observed fact that the speed of light does not depend on the motion of the observer. In this, his theory of Special Relativity, time and space are intimately related. This eventually led to his 1916 revision of Newton's laws, the theory of General Relativity. The latter is sometimes called the "relativistic theory of gravitation" and has turned out

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[illegible] in the United States.

Interestingly, Hertz set out to do his experiments at a time when Maxwell's equations were almost universally disregarded or disbelieved. Much to his surprise, he verified them.

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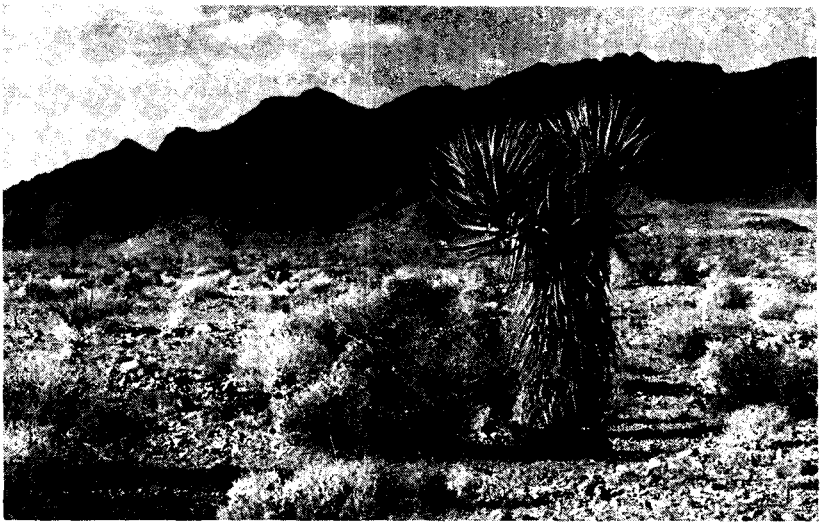

Mountains and trees are held on the ground by gravity and their chemistry is governed by the electromagnetic force. Photo courtesy of the Los Alamos National Scientific Laboratory.

to be as successful (when tested experimentally) as it is aesthetically beautiful.

Einstein spent the last 30 years of his life unsuccessfully trying to incorporate Maxwell's equations for electromagnetism into his gravitational theory. His motives were not, however, entirely altruistic. In part, the Unified Theories Einstein kept thinking up were "devised to avoid a scandal." The scandal was this. One of his equations for general relativity had, on the one side, a geometrical ancestry (the curvature of space-time); on the other, a phenomenological one. (The latter included the equivalent of an electromagnetic field—when there was one—and he was, of course, trying to find a general geometrical object to serve in its place.)

Einstein recognized the enormity of the task he had set for himself, writing as he once did to a friend: "The calculational difficulties are so great that I will be biting the dust long before I myself can be fully convinced of it." In fact, neither he nor others ever were convinced that the Unified Field Theory he was trying to find could successfully describe the physical world.

Einstein's failure, however, hinged more on the fact that, when he began

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his quest in 1925 the existence of the "weak" and "strong" forces was not even recognized. Also contributing to his difficulties was his distrust of, or disbelief in, "Quantum Mechanics," the theory from the late twenties, which has become a cornerstone of modern-day physics. In fact, Einstein expended a good deal of his time thinking up unexpected and clever inconsistencies to this new mathematical language, in which things can be described as both waves and particles, locations and motions are mutually uncertain, and the behavior of individuals cannot be precisely predicted.

But it always turned out that the inconsistencies were simply not there, and, as J. Robert Oppenheimer once pointed out, "often their resolution could be found in the earlier work of Einstein." Ignoring as he did this new language of the elementary particle world, Einstein had little chance of finding a correct mathematical description of the behavior of these self-same particles.

Quantum Field Theory, a synthesis of quantum mechanics and special relativity, does not make that mistake. As the thirties opened, we were introduced to the idea of an "exchange force." While this is not a new conception of force, it was nonetheless "unconventional." Atoms, we know, do not usually fly apart. This fact could now be explained in the first quantum field theory, Quantum Electrodynamics, by the continuous exchange of particles called *photons*[5] between the nuclei of atoms and their surrounding electrons. The exchanged photon—which in a sense "carries" the force—is said to be "virtual," because it exists for too short a time to be seen. When a photon is not virtual, it acts as the carrier of energy in a light (or other electromagnetic) wave.

In analogy (and in our table), just as electromagnetism is mediated by photons, the strong, or nuclear, force between two protons in the nucleus soon was recognized as due to an exchange of *mesons*, unstable elementary particles. (In another context, this force and its *gluons* bind together the quarks of which these self-same protons are said to be composed). The weak force is now believed to be carried by particles which go by the mind-boggling name of *intermediate vector bosons*. There is no reason to suppose that gravity is not also mediated by some particle, and that particle has been named the *graviton*.

The range of the force, quantum mechanics tells us, is inversely proportional to the mass of the exchanged particle. Electromagnetism and gravity seem to have an infinite range. Therefore the photon is massless,[6] and so

[4] The spontaneous emission of radiation from unstable atoms, first discovered by Henri Becquerel in 1896, involves a component whose source is the weak interactions (the "beta" rays). This force was not characterized as such, however, until the mid-thirties.

[5] Einstein had invented the concept of a photon some 25 years earlier.

[6] The experimental upper limit on any mass for the photon is very, very small.

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Force	Relative Strength	Range of Action	Carrier (or Mediator)	Theories Applicable
Strong	1	10^{-13} cm	Gluons Mesons	Quantum Chromo-dynamics Meson Field Theory
Electromagnetic	10^{-2}	Infinite	Photons	Quantum Electro-dynamics
Weak	10^{-5}	10^{-16} cm	Intermediate Vector Bosons	Unified with Quantum Electro-dynamics
Gravitational	10^{-39}	Infinite	Gravitons	General Relativity, Supergravity?

The four forces of Nature. The strong force has a range of 10^{-13} cm, about the size of a proton. This force, like Janus, has another face, which is believed responsible for holding together quarks in protons and neutrons. To mold a completely unified field theory, this other face of the usual "strong," or nuclear, force must also play a role.

must be the hypothesized graviton. The strong interaction has a small sphere of influence—no larger than the size of the nucleus, in fact. Its mediating particles, therefore, have masses a few hundred times greater than that of the electron.* (Such particles, the mesons, were found experimentally about 35 years ago.) The weak force interacts within a very short range, one-thousand times shorter than even the strong force. It thus is thought to be carried by a very heavy particle indeed, a particle some 80 times heavier than a proton.

It is because this intermediate vector boson is thought to be so massive that we cannot presently make it in the laboratory. (It is a good bet that this boson will be found in about five years, however.)

Quantum field theory can in principle be applied to all four forces. But, as Steven Weinberg, one of the physicists

*The masses of particles in the elementary particle world are often spoken of in terms of those of the electron and proton. If the electron has a mass of 1, the proton's is some 1800 times greater.

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who unified the weak and electromagnetic forces, points out, in such a mixture of quantum mechanics with relativity it was discovered that these two fundamental theories are nearly incompatible. "Taken together, they are extraordinarily restrictive," the Harvard University physicist says, "and they therefore provide us with a great logical engine."

The special class of quantum field theories known as "gauge theories," it seems, however, to offer hope of satisfying these logical restrictions. The central idea behind these theories is that they be backed up by a principle of invariance or of symmetry—which in turn demands the existence of the forces themselves.

The idea of symmetry, like that of [illegible] dates from Man's beginnings. [illegible] by which Man through the ages has tried to comprehend the world around him, beauty, and perfection in himself, physical symmetry [illegible] can do something to an object or understands it appears unchanged. For example, let's take the group of symmetries of a square. Turning a square on its side does not affect the appearance of the square. The square could also be viewed in a mirror, and it would still be a square. The four lines composing the square's boundaries can be disassembled and put back together again, and as long as the four right angles are maintained, the result is a square. Once a square, always a square. The form of the square is symmetrical, or, as a physicist says, "invariant" under rotations of 90 degrees, under reflections in a mirror, and under interchange of its parts.

A particle physicist, however, is not so interested in the form of a square as in the form of natural laws. If he could, he might carry a particle in his pocket—a pion, for example—from its birthplace at the "Meson Factory" in Los Alamos to Chicago. He would expect the pion's behavior to be the same when he arrived in Chicago (if he got there before it died) as it was in Los Alamos. Moreover, he expects that a pion made today will behave the same as one made yesterday.

Even were he somehow to put the machine that makes the pion into outer space, he would not expect the pion produced there to be different. The form of the natural laws of pions would not change. For our modern-day physicist is *not* a classicist. If he were, he would no doubt maintain that the rotation of the accelerator with respect to absolute space would subtly alter the laws. This is most definitely not the case, yet another thing we have learned from Einstein.

Since space-time is symmetrical, Einstein said, the laws of Nature are the same for a physicist on Earth and for another moving in the deep, outer reaches of space. A space-time interval

The name "gauge" was first applied in the sense of a "measure of length." It is just another historical accident that the name has stuck, since the original meaning has little to do with the physical significance of the theories.

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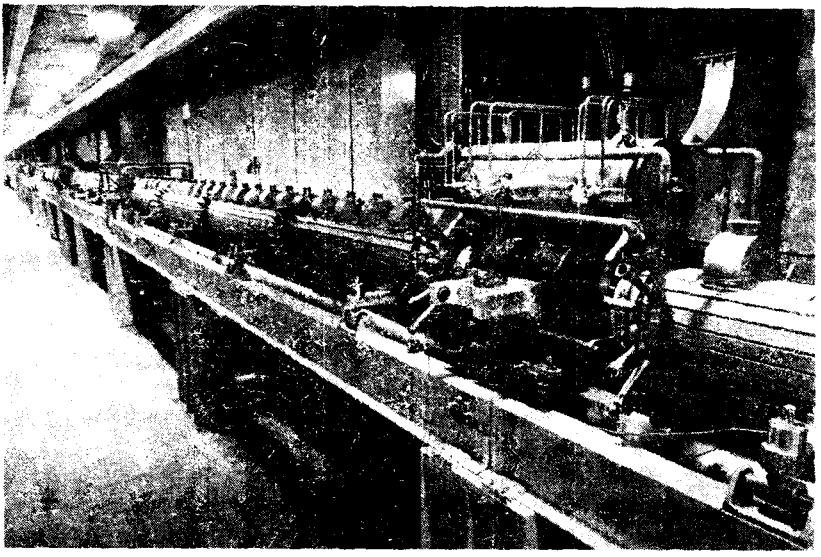

The Los Alamos "Meson Factory." This linear proton accelerator utilizes the electromagnetic force and is used for investigations of the less-well understood "strong" and "weak" forces. Photo courtesy of the Los Alamos National Scientific Laboratory.

between two events measured by these two observers is, moreover, also the same, an "invariant." This implies a deep connection between symmetry and invariance (and is why the words are often used interchangeably). If something is symmetrical, this, in its turn, means that something else remains ever more the same, or is "conserved." In the case of the pion, Einstein's space-time symmetry says that particle's rest mass is always the same for all experimentalists.

Not only do symmetries in Nature imply the existence of conservation laws, they also—at their best—require the existence of the force itself. To see how this is possible, we must detour a bit and talk of "global" and "local" symmetries. Our example of the laws remaining the same whether the Meson Factory is on Earth or in space is an example of a global or overall symmetry. While global symmetry sounds the "grander concept" of the two, it is not.

Two of the physicists deeply involved in developing the theory of supergravity (we are still coming to it) are Daniel

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Freedman and Peter van Nieuwenhuizen, both of the State University of New York at Stony Brook. They point out that local symmetries are more stringent. The difference between the two is rather like the difference between rotating a basket of apples from one orientation in space to another and separately rotating each apple in the basket to various different new orientations.

To illustrate this, Freedman and van Nieuwenhuizen have sent up a trial balloon. Imagine this ideal spherical rubber balloon to be marked in such a way with a system of coordinates so that each and every point on its surface has its position exactly identified. If this balloon is then rotated about some axis, the form of the sphere remains unchanged. This is a global symmetry because all the points on the surface are changed by exactly the same angular displacement.

A local symmetry operation, in contrast, will stretch the balloon in places and squeeze it elsewhere by moving the points on the surface *without* altering the balloon's shape. Because of the stretching and compression, forces will be introduced between points on the balloon's surface. These forces moreover give rise to force fields. The force of gravitation, for example, may well arise in the transition from a global to a local symmetry.

Theories with local symmetry are called "gauge theories." It is their mathematics which relates geometrical transformations in space and time and the symmetries that define the quantum properties and interactions of particles. Maxwell's theory of electromagnetism is the oldest gauge theory. To illustrate the power of the local symmetry behind it, let us say only that, starting from the symmetry, one could proceed to deduce *all* the properties of electromagnetism, including Maxwell's equations and the fact that the mass of the photon is zero. That's not the way it happened historically, but let us not dither about that.

As a consequence of symmetries, the many elementary particles can be said to conserve certain quantities, such as mass and charge. Mass, for example, is somewhat easier to grasp than some of the "newer" symmetries.[8] We will discuss briefly only one other, "isospin symmetry," which establishes a fundamental relationship between the proton and neutron. When the neutron was first discovered in 1932, physicists were rather surprised to find it so much like the proton. These two particles seemed to have almost the same mass and to differ essentially only in that the proton had a positive charge, the neutron none at all.

Werner Heisenberg set out to explain this by inventing a new space, quite unlike that we live in. This space he called "isospin space," and, in it, the proton and neutron are viewed as only two different faces of the same thing, which he called a "nucleon." Each nu-

[8] Actually, the concepts of mass and charge are equally as abstract; they have just been around longer, since the time of Newton and Benjamin Franklin.

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cleon is thought to have an "arrow" associated with it. If the arrow points "up" in the fictitious space, we see a proton, if "down," a neutron.

Transforming the proton into the neutron, or vice versa, is a symmetry operation in this isospin space, and it does not change the equations describing the strong forces between nucleons. Transformations in isospin space are overall, or global, in Nature. Just as Heisenberg's isospin space was for the longest time regarded as "only a mathematical trick,"[9] so too was the mathematical extension of it from a global to a local symmetry.

It was in 1954 that Chen Ning Yang (now also at Stony Brook) and Robert Mills of Ohio State University first published this extension of isospin symmetry as an elegant field theory, and, in so doing, showed that still more complicated gauge theories than electromagnetism could exist. One reason this mathematics lay fallow in the "bag of curiosities" for more than a decade was that, despite its elegance, it had no physical applications. For example, the transition from a global to a local theory required all the particles which mediate forces to be massless. The photon, we know, is massless. But we think the intermediate vector boson has to be very massive. (Recall the earlier quantum mechanical argument.) How to reconcile this was a serious problem.

The reconciliation came slowly and depended on what some physicists have, at first sight, called one of the most remarkable developments of the last 50 years—the realization that *broken* symmetries also exist in Nature. At second glance, it is perhaps not so surprising. For as Werner Heisenberg once replied when asked why God created a world with asymmetry in it since obviously perfect symmetry would be more appropriate to a Deity—"Only nothingness is absolutely symmetrical and there would be no point in creating that!"

An example of a broken symmetry in the ordinary macroscopic world was pointed out years ago by Herman Weyl—that of the one-celled "radiolarian," a marine animal called *Aulonia hexagona*. Its skeleton is basically a hexagonal lattice bent into a spherical shape. With only a cursory observation, one would conclude that all cells have six sides, but, indeed, a closer look reveals some with only five. The interesting point, as Weyl said, is that the imperfection of the symmetry is unavoidable for topological reasons.

In a similar way, approximate symmetries seem necessary for the understanding of elementary particles and their forces. For, there is a strange and still far-from-understood thing about the four fundamental forces of Nature as we know them—the stronger the force, the more symmetrical it is. That is, the stronger forces seem to be more constrained; they conserve more quantities than weaker forces. Broken symme-

[9]We now know it to be a real symmetry of Nature, allowing one to make predictions which can be (and have been) verified by experiment.

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tries which involve violations of the conservation laws valid for the stronger forces, play a most important part for such as the weak force.

"Spontaneous symmetry breaking" is a way of explaining how Nature can make, for example, the weak force look so different from the electromagnetic force when they both, we now think, are at some level quite the same thing. It has, in fact, been called "only an accident of Nature" that we do not live at a temperature of 10^{15} degrees and we therefore notice the difference between the weak, the electromagnetic, and the strong forces. In the original heat of the Big Bang, which created today's Universe, all the forces may have been one. It is this original symmetry which physicists today hope to recover (or understand).

The mathematical concept of spontaneous symmetry breaking[1] allows us to revise and extend the Yang-Mills field theory in such a way that the intermediate vector boson occurs as a result of the local gauge theory as the carrier of the weak force. Moreover, it can now exist with its very large mass. Yet the photon can remain—as we know it is—the massless carrier of the electromagnetic force.

The first modern-day unification of the forces had to wait upon this idea of spontaneous symmetry breaking. In 1967, Weinberg, and independently a year later, Abdus Salam of the International Center for Theoretical Physics in Trieste and Imperial College in London, were able to write down a theory linking electromagnetism and the weak force.[2] Their work stood on Sheldon Glashow's earlier elaboration of the Yang-Mills gauge theory, and, for this, the three shared the 1979 Nobel Prize. While the Glashow-Weinberg-Salam model is, in some of its aspects, still being tested, there nonetheless exists a good deal of rather convincing evidence in its favor.

Where have we come? Where are we going? No one knows. But today, physicists understand the weak and electromagnetic forces in terms of one local gauge theory, just as Maxwell was once able to explain the forces of electricity and magnetism in one. Many physicists are now striving mightily to incorporate the strong force described by its own gauge theory (with the colorful name of "Quantum Chromodynamics"). In the meantime, others, as we said in the beginning of this story, are beginning at the other end—by trying to extend Einstein's theory of general relativity to a gauge theory called supergravity.

Supergravity depends not just on symmetry but—yes, you guessed it—"supersymmetry." As Freedman and van Nieuwenhuizen point out, it makes the *same* predictions for the clas-

[1] This is an idea which originated in an entirely different discipline, the physics of ferromagnets.

[2] John Ward (now of New Zealand, then at Johns Hopkins University) also had similar ideas; he, however, tends not to receive credit for he somehow never managed to formulate his ideas as crisply as did Glashow, Weinberg, and Salam.

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sical tests of Einstein's theory.[12] It is in the sub-microscopic world of the elementary particle that the differences between the two theories show up. The gravitational force is due, as already noted, to the exchange of gravitons. Supergravity, however, introduces other particles which can, in pairs, also interact with matter over very short distances. These are the gravitons' siblings, the "gravitinos" we spoke of earlier.

The idea of supersymmetry occurred to a number of physicists, working independently in the U.S., the U.S.S.R., and Europe. It was discussed as early as 1971 by two Russians at the Lebedev Institute in Moscow, but the work went unnoticed. The same concept thus was rediscovered two years later, again in the Soviet Union, but this time in the Ukraine, in Kharkov. It might have remained buried, were it not for the fact that similar ideas were then being published in the West. In 1973, Julius Wess of the University of Karlsruhe and Bruno Zumino at CERN in Geneva, Switzerland, gave the idea of supersymmetry a quantum field theoretical underpinning.

Ignoring all the "super's," the idea is a simple, albeit revolutionary, one. Instead of relating particles with the same spin (as does isospin symmetry), the supersymmetry-supergravity folk are trying to relate particles with different "spins." That common bonds—symmetries—have been found between two classes of particles, which are essentially not at all alike, is truly remarkable. Fifteen years ago had any physicist publicly stated this to be a possibility, he would no doubt have been laughed at. Now it seems, according to very recent work by Franco Iachello of Yale University and the Netherlands, that such (dynamical) supersymmetries do appear in Nature, showing up in the energy spectra of complex nuclei such as platinum. Whether this is *also* the case in the elementary particle world remains to be seen.

It is the identification of this common symmetry between particles with different spins which leads to the hope that—even if supergravity does not lead to an eventual unification of all four forces—it may nonetheless provide a clue as to how to treat gravity "not separately, but equally," via a quantum field theory.

But what is this "spin" stuff? It was first recognized in 1925 that an electron not only revolves in an orbit around the nucleus, but at the same time revolves around itself. This is not much different from the Earth circling the Sun, while also spinning on its own axis. This intrinsic quantum mechanical angular momentum of the electron, called "spin," is not, however, a characteristic only of electrons. Each and every particle has its own spin (if you count

[12]The three tests Einstein himself proposed were the bending of starlight near the Sun, the red shift of stellar spectral lines, the precession of planetary orbits. These effects have now been measured, Einstein's predictions verified.

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[illegible] and the existence of this spin [illegible] affected at the expense of [illegible] the density of the particle [illegible]

[illegible] thing is that when the [illegible] relativity and quantum [illegible] unified in the late [illegible] field theory, the [illegible] electrons has [illegible] restricted a degree [illegible] between particle [illegible] properties of a system made [illegible] identical parts de[illegible] described in way [illegible] that [illegible] doesn't [illegible] simply put, two [illegible] of spins obey different [illegible] statistics.

All particles in the world, we now know, can be divided up into two classes—those that obey Pauli's Exclusion Principle and those that do not. The point of the principle, which is the key to interpreting Mendeleev's periodic table of the chemical elements, is that no two electrons can be in the same place with all the same properties at the same time. Were it not for the exclusion principle, all the electrons in an atom would automatically cluster in the lowest energy level. Certain other particles—like the proton and neutron[1]—also obey the Pauli principle. In appropriate quantum mechanical units, all such particles have half-integer spin and are called "fermions" after Enrico Fermi, who first noted the kind of statistics these particles obey.

The statistics are entirely different for the other class of particles in the world—those which, like the photon and hypothesized graviton, have integral spin. These particles, because they obey what is known as Bose-Einstein statistics,[2] bear the name of "bosons." In contrast to fermions, two or more elementary bosons *can* occupy the same point in space or the same quantum state. They even *prefer* being together. An example of this is the coherent light of lasers. In a laser beam, photons, all moving and spinning in the same direction with the same energy, are superimposed, one on another. Other examples of Bose-Einstein statistics lie in superconductivity and superfluidity.

The simplest supergravity theory describes a world which consists of just two elementary particles, the graviton (a boson) and its little sister, the gravitino (a fermion). Obviously, without protons and neutrons and electrons to build atoms, this would not be a very

[illegible] change spin directions.

[illegible] reason [illegible] the name "statistics" has to do with how a statistical weight is assigned to a given [illegible] particles.

[illegible] because neutrons [illegible] effect "repulse" each other that stable neutron stars exist. Without such a [illegible] neutron star would continue collapsing down the evolutionary road to become a gravitational singularity—a "black hole."

[illegible] these represent Einstein's last important positive contribution to quantum theory; afterwards, he assumed the role of critic.

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satisfactory—or comfortable—world.

But which other particles are really fundamental and therefore demand inclusion? Despite the fact that the question is unanswered, we can nonetheless see how an extended supergravity theory might one day be used to describe the world. Imagine a particle like the nucleon in its own special space. This particle—or rather "Super-particle"—can be thought of as having a Super-arrow in an auxiliary Super-space of many dimensions. As the arrow rotates, the particle becomes in turn a graviton, a gravitino, a ———, a ———, a———, and so on. (The blanks can, hopefully, soon be filled in.) And again, in analogy to isospin, it is when the arrow points "up" that we see a fermion, "down," a boson.

The problems with supergravity turn on Einstein's oft-quoted dictum that "experiment lies at the Beginning and End of theory." Putting together fermions and bosons and deriving all the forces from the common requirement of local symmetry is mathematically "elegant." Supergravity—like "the other brands" of unified field theories—starts with the prejudice that "deep mathematics and deep physical understanding ought to go together." While mathematics allows physicists to give free reign to their imagination, it must also reflect Nature's symmetries to be useful. In this, thus far, supergravity fails; it is both incomplete and untested.

Nonetheless, even if supergravity is not the *final* solution to all the problems, the practitioners of this art are hopeful that some future development of it may be. There are three directions in which the history of this subject might go, which are profound and at the same time speculative.

First, the development of supergravity may lead us to re-think our concept of what is really elementary in the particle world and to the correct quantum field theory for gravity. If we can ever talk of gravity together with the three forces of the elementary particle world in terms of quantum fields, we will indeed have revised our concept of the very meaning of force.

Second, supergravity might allow an understanding of what happened at the moment of creation. As it is now, the first 10^{-35} seconds of the Universe are necessarily and completely shrouded in mystery. An explication of this very early history of the Cosmos will, some physicists feel, probably have to await some new physical theory that "links and synthesizes the theory of relativity and quantum theory."

The third possible development may be that anti-gravity is not such a crazy idea, after all. In a very recent paper, Joel Sherk, a well-respected French mathematical physicist, explores the mathematics of supergravity and finds that it "can lead naturally to anti-gravity."

To put this latter point in context, Einstein's general relativistic theory of gravity implies that anti-gravity is impossible. However, as Sherk points out, a quantum mechanical theory such as supergravity might well allow such a force to occur (presumably as a "quan-

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tum effect"). If so, there may be objects with negative mass which possess negative gravity. After all, why shouldn't things fall upward, as well as downward? Why shouldn't there be a Super-Gravity-Man who can leap tall buildings at a single bound, nevermore to return to Earth?

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Robin Kincaid

WE'RE WORKING ON IT

As the ways research is done change, it gets harder and harder to do it the old ways. And more important that some, at least, try...

Brad Hamann

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In all my years as a time machine repairman I had never seen anything like this. And I thought I'd seen it all: kitchen and household articles ruined, kids' toys busted, once—I still shudder—an enormous diamond cut in two. The owner wanted to know if we could repair *that*. Then she threatened to sue when we explained the effect was irreversible. As if the machine had broken down. The damn thing worked fine; she was the dummy who let her finger get too close. She could have lost that, and I told her so. No use. Rich folks who lose their goodies are beyond reason.

Finally I told her that when they invented a way to send backward instead of just forward we'd come and stick it back together for her. Sarcastic as hell, and you know, I think she believed me? Some people.

Actually I did see a finger lost once. There have been quite a few such accidents, of course, although they're a lot less likely than with, say, an electric knife. But usually the victim calls a doctor, not a serviceman. This one time, though, the guy was in shock and just calmly called us. I went out and found him bleeding all over the place, angry as hell. He'd been trying to fix the thing himself, and I think his pride was hurt that he'd blown it. I called an ambulance. He was just beginning to realize he was hurt when they took him away.

So anyway, on this particular morning I took this call and all I could get was that the woman was hysterical and that it had something to do with her kitchen unit. I naturally assumed it was some kind of serious injury. I told Randy to call the hospital, then I got out there as fast as I could. But when I arrived I was met by a perfectly healthy-looking woman who just happened to be semi-incoherent and kind of pale. She managed to affirm that she was unhurt, so I rang Randy and told him to cancel the ambulance. It was halfway there. I guess they were less than enchanted.

Well, no way would this lady go into the kitchen with me, so I went in expecting I don't know what. All her stocks and bonds sliced in half maybe; I don't know. The machine was sitting on the counter, looking innocent enough, as they all do if you understand them. Some people see them as near-magical and impossible to deal with. But that's not peculiar to time machines. My grandfather was scared to death to use the telephone. He considered it a completely arbitrary device that would get you whomever it felt like at any given moment and could not be deciphered or understood by mortal man. Mortal woman was a different story: he had my grandmother make all his calls.

I walked up to the machine and peered down at it. A medium-priced unit, a couple years old—laminated plastic sending surface, turquoise-colored control panel, transparent shielding. (Yeah, I know nobody says "laminated plastic." I'm just habitually careful. I had a friend once who got sued because he used the brand name for cellophane tape in print. If he couldn't get away with an S-word, I'm not about to risk the F-word.) No frills on this model, just ON/OFF and an operating button on the raised platform that held whatever was being sliced. I'd worked

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on hundreds of them. And it was immediately apparent what had happened here — or at least I thought so. I'd seen similar things — no big deal, just an accident.

There was a dead mouse in the thing.

I groaned in exasperation. I mean she could have handled this without the dramatics. Personally, I'd never known anyone who was honest-to-God afraid of mice, particularly dead ones. But sooner or later, servicemen get not only all the weirdos, but all the clichés.

Still, I guess it was a pretty gruesome sight. Dead is one thing, but sliced clean in half? Could be unsettling if you weren't prepared for it. Especially before breakfast.

There was nothing for it but to clean up the mess and test the machine. I chucked the back end of the beast into the sink and wiped up the blood with a sponge. It seemed obvious what was wrong. The machine was designed to shut off automatically, for safety reasons, if it had been on for thirty seconds without operating. You had to press the button on the platform in order to [illegible] the part of your cards that projected over the edge ahead of time. It was a rather touchy button so you could press it repeatedly and rapidly. Evidently the beastie in there had turned the machine on and then either forgotten about it or left it to turn itself off. But in doing so, the automatic had malfunctioned — the mouse had wandered across the counter in the night, hit the button, and died. Then it had turned off as it should — which I could see by the position of the switch.

Still, I checked it before I got my hands too near. I stuck the sponge out past the platform and hit the button. Nothing. Okay, safe. So now I could start pulling it apart. But first I had to get rid of the other half of the mouse. I reached below the counter to remove the plastic bin under the machine, prepared to confront the head end of the beast. I confronted nothing.

The bin was empty.

This really ticked me off. I mean here was this woman so hysterical she almost gave me heart failure on the phone, but she'd been calm enough to do half the clean-up herself. And put in a new plastic liner yet.

I went into the other room. "Hey, excuse me, but did you get rid of the front half of the mouse?" She looked like the mere mention of it was going to make her sick.

"Certainly not. I didn't even look in there. Why do you think I called you?"

"Well then, who did?"

"Nobody. What do you mean? It's still in there as far as I know. I mean it's got to be—doesn't it?"

I nodded. "Yes it does—as far as I know." I went back into the kitchen, a bit confused.

Now as I said, I thought I'd seen everything. I even saw a parakeet lose its tail feathers in one of these things once. But the feathers had been right in the bin where they belonged. This bin was clean as a whistle. I decided to give the machine a test before I pulled it apart. I didn't speculate on what was wrong, just set out to look for it. Very scientific. It wasn't too difficult a position to take, since I hadn't the foggiest notion what could have caused this.

I turned it on, stuck the sponge in it,

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and pressed the button. There was the familiar low click, an almost instantaneous blue glow just as soon gone, and the right half of the sponge disappeared with a crack of rushing air. The unit shut off two seconds later, and I was holding half a sponge, sliced cleaner than an infinitely sharp razor blade could have done it. So far, so good.

I crouched down and peered into the bin. Half a sponge, right where it should be. I sighed and started unscrewing the front panel.

It took only minutes to fix the timer that worked the safety. I switched the unit on, left it alone for thirty seconds, and bing! Off it went. I put it back together.

Well, the sponge was ruined anyway, and I was still puzzled, so I took the remaining half and ran it through again. Same click, same glow, same disappearing act, same noise, same clean cut. I looked in the bin.

No sponge. Empty bin.

This was ridiculous. It couldn't happen. The thought crossed my mind that the woman was a magician, testing out a new illusion on me. No technological answer came to me, because there was none. I am a bloody expert on time machines of all types, and this was impossible.

Oh, yeah, it was *theoretically* possible of course, but no one had the faintest idea how to do it, or what to do with it if it could be done. All we had been able to do so far was transmit things a fraction of a second into the future. They went out of and came back into phase almost instantaneously, for most practical purposes. Nothing like H. G. Wells or the whole string of stories since then. But then of course Wells had missed an essential point. When something is time-traveling, it's out of phase with the world around it, and therefore intangible. Wells got that: his Time Traveller found himself passing through solid objects with no problem.

Wells also assumed the effect of gravity on a time-travelling object. His time machine stayed put on the surface of the Earth. What he—and everyone else, I guess—forgot to allow for was the interaction of these two effects. His time machine was intangible to that surface. Put that together with gravity and you don't have *The Time Machine*, you have *Journey to the Center of the Earth*.

Anyway, all the stories assumed infinite travel, and no such thing was possible, although God alone knew why. We were sort of in the position of trying to solve that famous sticker about the map colors, however that went; I don't know, I'm a technician, not a scientist. I just know all about time machines because I owe my life to one.

I thought about that as I set up the unit for another try. This time I was going to keep a lookout in the bin. I switched it on, shoved a screwdriver in, and hit the button, reaching up to do so while I crouched by the bin. Nothing materialized, the machine shut off, and I was the proud owner of half a screwdriver.

I guess I was trying not to think about it, but I knew what must be the answer. The screwdriver blade had gone out of phase, for sure; which meant it had become intangible with respect to the counter-top. Gravity would then have had to pull it through the counter—and the bin. And the floor below.

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On impulse I straightened up and hurried down into the cellar. Over in the corner under where I judged the counter to be I searched the floor, and found—a piece of sponge. And more. No, no half-mouse, no half-screwdriver. Fragments of concrete, torn up from a heave in the floor, with dust and smaller chunks scattered for five or six feet.

The sponge had materialized somewhere between the ceiling and the floor. The mouse, or the screwdriver, or both, had materialized under the floor, with enough violence to blow the cement loose. I left the sponge there. It made me nervous, somehow.

I went back upstairs. *Another great boon to humanity.* I found myself muttering. Just like the automobile. The automobile. The discoverer of the time travel principle—okay, one of the nearly simultaneous discoverers; the first to announce, weeks ahead of the more cautious Princeton boys and the Soviet team—had been killed in an automobile. He was the old-time lone eagle inventor type, and insisted on testing his new toy himself. He figured it would make a great auto safety device. See a crash coming? Blink out of phase and come back a couple seconds in the future, having passed clean through the other vehicle. Of course there was no way to mount the thing in the car and still send the whole car and itself. But he figured he'd solve that later.

So he built a big unit, set it by the side of the test track and rigged it up to a photo-electric cell to be tripped by the car. Then he drove past it. Having reckoned without gravity, his wheels sank into the ground. Not far, of course; as a matter of fact, the exact distance between a counter-top and a bin. That was the only distance possible.

It was far enough. When he and his car popped back into phase, the resulting explosion flipped the vehicle over three times, in the air. He was dead before he landed, perforated by pieces of the road and floorboards.

But a boon to humanity it was, once they'd calculated the interval with accuracy. Witness my case: terminal cancer. A laser hologram taken of the malignant cells, a computer-operated three-dimensional time scalpel, and zap! The malignancy drops into a plastic bag under the table, having gone clean through me and it. After that I was fascinated by time machines and made them my work. Read all I could, loved the stories about people time-travelling, and wished it were possible.

Now this thing had dropped into my lap, or into the woman's basement, with all sorts of nasty implications, and I didn't like it one bit. It scared the shit out of me. Somehow I had to test that machine, more thoroughly than I could here in its owner's house. I fed her some garbage about needing special calibrating instruments. Luckily she didn't know beans about machinery, so she bought it. I removed the works, carried them out to the van, and headed back to the shop.

"Holy Christ." That was Randy's only comment when I told him what had happened. I didn't need to explain my theory. He knew time machines as well as I did, although he didn't study for years like me. He did it in the way that's becoming so popular these days, with a direct knowledge infusion, which of

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course had to be renewed regularly. I guess I was sometimes guilty of acting holier-than-thou towards him because of that.

"So how long do you estimate the time span to have been?" he asked me.

"Lord, I don't know. Ask a physicist. Maybe double, maybe triple normal? Long enough for a piece of sponge to fall through the floor, and longer, for the mouse and screwdriver to fall farther than that."

"One of 'em, anyway. The other one, who knows? Maybe not as far."

"Hm?"

"It could be inside the floor. Between the floorboards."

"Jesus, I never thought of that. Or it could be God knows how far below the cellar floor."

Randy nodded. "And wait'll we tell that lady they're gonna dig up her cellar to find out."

"Dig up? Why?"

"Well you don't think we're gonna keep this thing to ourselves, do you? The lab boys will have to know, and the underwriters." (Randy was the practical sort.) "Besides, if we really have discovered a way to extend the time span in these things, we might get a piece of the pie."

I had to agree. "It would help if we could get some idea what caused it before we report it," I said. "I mean, we can at least check out all the components and see if anything's out of the ordinary."

"Right. Let's get on it."

We did, but found nothing amiss. We finally put it all back together and ran it through test after test. About fifty percent of the time it performed as it was supposed to. The other fifty, though, it did what it had done out at the house. We ended up with all kinds of wire and other loose junk in our basement and, presumably, below it. Not to mention a gaping hole in our shop floor (the basement ceiling) where a thankfully tiny chunk of solder materialized and nearly blew me off my feet.

We returned the thing to the manufacturer's labs. Personally.

We had to go through all sorts of rigmarole with CONFIDENTIAL security badges and like that. Time Design, Inc. was a government sub-contractor; they could afford the best. We were finally ushered into the luxurious office of a Dr. Keane, administrator and real blue-chip physicist. We had already told our story to his assistant on the phone.

(You may wonder how I can get away with naming the two big time machine corporations but not the laminated plastic company. Easy. If this ever gets into print, one outfit will love me. And the other one's currently trying to kill me. So I say, what the hell, let 'em sue. It'd be a relief.)

"Make yourselves comfortable, fellows," Keane said, indicating two chairs covered in genuine leather. I couldn't tell whether the "fellows" was supposed to be good-old-boy stuff or just snobbery. It rang phony in any case. "Sorry about the delay at the gate. Government regs. We do some of the basic research on time machines here and naturally the Washington—or should I say Arlington?—types don't take chances."

"What would the military want with time machines?" Randy asked. He got a condescending smile and deserved it.

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"Well, just for a tactical example, think what a soldier who could blink himself momentarily out of phase would be capable of," Keane replied. "He could slip through obstacles, dodge weapons—and imagine intelligence agents who could, in effect, walk through walls."

Randy shrugged. "Sure, but they'd also sink through floors and get stuck inside walls unless you could control gravity and duration."

Keane nodded. "Precisely, Mr. Cerbow." His eyes went from our, or rather Ms. Frannie's, unit, sitting on a table, to Randy and me with a look on his face which classified the glance as Significant.

I spoke up. "You're saying that what we've discovered could be a breakthrough for research in general and the military in particular."

Keane smiled. "Not *could* be, gentlemen," he suddenly formal—"*is*." He leaned back in his swivel chair and locked his fingers behind his head. "You see, gentlemen, until I discover this effect, you only thought-tested it."

My expression felt as blank as Randy's looked. Keane chuckled, not unkindly. "Truth," he said. "You see, we designed that unit to do exactly what you caught it doing. Did you really think it was accidental? Experimental, yes. Look: a time machine produces its sending, or projecting, field by activating a crystal with a combination of light waves and sound vibrations at precisely controlled frequencies. Similar to a laser. Quite complex in principle, but not hard to do. The crystal radiates particles which penetrate anything within the field except the shielding. We know how far ahead an object will travel by the decay time of these particles, a fixed quantity. Knowing how far matter will fall in that time span tells us where to put the bin."

All this we knew. But now he sat there looking like he was waiting for a leading question. I'm an easy guy to get along with, so I gave him one. "Since the decay time is fixed, and we assume gravity hasn't changed, what went wrong with that unit?"

"As I told you, nothing. It was planned. You didn't figure it out because you tested all the working parts, and none of them was in any way out of the ordinary. This was." He pointed to the crystal. "A new crystal, gentlemen"—like he was introducing a political candidate—"like its fellows but with certain impurities which give its particles a variable decay time. Variable, and thus far unpredictable."

Randy got it out just as I was opening my mouth. "What's the outer limit of this thing?"

Keane shrugged. "We don't know. Obviously at least a few seconds. But personally I believe it could be unlimited."

My turn now. "All right, so how come on the one hand we've heard nothing about this and on the other it turns up in a privately-owned kitchen unit?"

"Two reasons." He took what he evidently intended to be a dramatic pause. "First, only myself and a few others know about it. We want it that way. We need testing; hence, we need technicians. We can't trust the house staff, so we had to go outside. Therefore it was placed in a sale unit to be tested in the field.

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"Which leads to the second reason. We wanted you two specifically to test it. And we wanted you to come here."

We didn't say a word; the question was on our faces.

"Because, gentlemen, we wanted to recruit you. There are only five of us here who know about these." I noted the plural; I also caught the slight emphasis on *here*. "Those five are myself and my assistant, whom you spoke to, and three other researchers. None of the technicians. This group comprises the crystal's discoverers, that is myself and one other, plus those few we could trust. We don't want either the company or the government to know about it. No, we're not planning anything underhanded or even melodramatic. But if we have discovered the key to the infinite extension of future travel, we don't want it snatched away for the wrong purposes." He took a deep breath, let it out. "Pentagon purposes."

We were all silent a moment. Then I said, "Okay. I can see that. So why us?"

"Maybe because you can see that. We screened repairman all over the East Coast, trying to find those we thought would have similar outlooks to ours. We then planted experimental units in their areas. Three of them. I arranged to have your calls routed to my assistant. You two are the first to report."

"What if we hadn't kept it secret?"

"As I said, we screened you two pretty thoroughly. I may disagree with the government's keeping dossiers on people just because they work on machines made by a sub-contractor, but the files did come in handy. I knew you two politically, also that you were responsible—and curious—types who would be more interested in bringing this to the right people for answers than making wild public pronouncements. Actually it wasn't such a risk. We could always claim ignorance, say that the crystals were just an accident. It's not so cloak-and-dagger as it sounds. We just see better potential uses for time machines than as instruments of war."

"Such as?"

"Well, as it stands, even without solving the gravity problem, there are possibilities for mining, drilling of all sorts, demolition, excavation, seismography—just imagine being able to sink things to any depth and have them rematerialize. And then there's space travel."

"I don't see—"

"Look, in space the gravity problem would be of a whole different order." He was getting excited. This was clearly his pet topic. "Intangibility would be no sweat. You're not going to sink through anything while you're weightless in orbit or free fall. Put a crew aboard a space craft, send them ahead a few weeks to the next time someone's needed. Saves food and other supplies, cargo space, wear and tear on the crew, and so forth. Solves the boredom problem! They do their job, you send them ahead again, and on and on. They do a year's worth of work and only live through a week of subjective time. No need for suspended animation or cryogenics or any of that."

"What if someone drifts through the wall of the craft while intangible?" I asked.

"Hey, I haven't solved any problems at all yet, men. I'm theorizing. No, I'm

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not: I'm speculating. I don't know what we can do. I want to find out. Matter of fact, some of the things I want to find out will have to be found out in space. But that's later on."

Randy nodded. "All that's a far cry from where we are now for sure. All we have is a hint that the theory of future travel may be true. Even so it may have its limits or be totally impractical."

"It needs testing," I said. "Lots."

"Precisely where you fellows come in. You and the other two teams. We already have a schedule of test procedures and a batch of equipment set aside for you. We want you to work in your own shop, in secrecy of course. And naturally you'll be paid. You will speak only to me or my assistant about your work, making irregular progress reports."

"Whoa!" I stopped him. "Sounds a lot more cloak-and-dagger than you said. How risky is all this gonna be?"

"Not too. I mean we're not suspect, and we haven't really done anything illegal. Just stuck a couple of bum crystals in a couple of machines. Or possibly withheld information from the company, for which we here can lose our jobs. Your guys should be in no danger. Today's now."

"The real reason for the secrecy is the competition."

"Time Techs?"

"Right. Listen, it's axiomatic—one of the historical truisms—that many new technological advances are discovered simultaneously, or nearly so, by different researchers. It's also common knowledge that big outfits like theirs, and ours, engage in espionage against each other. It's likely that Techs is on the trail of these same impure crystals. I *don't* want them to know that we are."

"So it's a race, you think."

"Likely. They'll get there, eventually. We all will. Mother Nature's a blabbermouth: can't keep a secret. Look at the orbital tower. It's popularly believed that that writer, what's his name, Clarke, first thought of that. But he didn't. There were three or four others, some in advance of him, others nearly simultaneously.

"But if we make it first—well, I know *I* won't sell to the Pentagon."

Randy and I looked at each other. We'd worked together a long time and didn't have to talk much. I turned to Keane. "We'll—consider it."

"All I ask."

"What would be first?" asked Randy.

"What would be, is. Take the unit home with you. Play around with it. Might help you make up your minds." This guy had studied our dossiers for sure. He knew we were gadget freaks.

So we agreed to do that much at least. We picked the thing up, shook hands, and started out. At the door I suddenly remembered Ms. Frantic and, turning, said: "Hey, what do I tell that woman about her machine? And her floor?"

Keane grinned. "That she got a lemon. There's a new one, our best model, already on its way. Floor? How about sound vibrations from the bum unit? Tell her we'll pay."

Keane had us figured. We didn't debate a day before accepting. He gave us a series of tests to perform, some equipment, and we went to work in our shop basement. We had to do it weekends and evenings, but the machine was simple if you understood it, so the tests

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weren't complicated. It was mainly a matter of keeping records. The other two units, whoever had them, had different types and concentrations of impurities in their crystals. Keane hoped that by comparing test results, patterns and deviations therefrom would be found. Keane's assistant was running the same tests on a normal machine as a control.

One pattern we'd already discovered remained consistent: the machine projected further than normal just about fifty percent of the time. There was no way to predict which times these would be, though. I figured that probably had to do with the distribution of impurities, but I was just speculating.

Another pattern showed up very soon, one that seemed much more significant. The thing's projection times were all in tenths of seconds—but only certain multiples. That is, its basic projection was 3/10 of a second. That was true for all commercial machines, and made for a drop just right for convenient bin placement, about a foot and a half. We got it to do 2/10, and 4/10, which caused things to land about six inches above our basement floor, and was thus the longest sending we could observe directly. Then it did 6/10, then one second, then up to 1.6, which it did a lot of the time. Then 3.7, then a huge jump to 102.4, well over a minute and a half. Then double that, nearly three and a half. These were the most usual. We got others occasionally, the longest being 2070.5 seconds, or nearly thirty-five minutes.

Keane had given us a device for measuring the radiation given off by the crystal on each shot and absorbed by the shielding. We correlated that with the shorter observable times and developed a measure for length of time projected. From that we could calculate distance fallen.

We got pretty good at guessing times and distances from feeling the vibrations of the floor as the junk we sent phased back in. The concrete had cracked and split completely apart below the machine.

The frustrating problem, of course, was all those missing times. Why no 1/10? Why no 5/10? And so on. If the times we got were the only ones possible, then even if the thing did become predictable, and even if it extended infinitely, there would only be certain numbers of days, years, or whatever that could be spanned. With this particular crystal anyway. We kept tables of projection times, hoping to fill in the missing ones. A few we got; others remained maddeningly elusive.

I was working on those tables the night the machine almost killed me.

Have you ever tried to force a machine to do something it just won't do? Deep down I don't think we've fully accepted the laws of mechanics. We still have a primal belief in brute force that takes over from our intellects when we get just frustrated enough. Even a trained technician like me. And I get frustrated when I get tired.

I was tired that night, a Wednesday I think, tired from logging data, tired from getting the usual results over again. I'm basically a tinkerer, and I get impatient with theoretical work. I want nice cold hardware in my hands. So in this case I was doubly frustrated: not only was I dealing strictly with data,

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but it wasn't even observed data, since we had to calculate the reappearances of things that fell farther than our floor. I got downright pissed at the unit, to tell you the truth, for never having given us a projection of 1/10 of a second, which would have been observable. It seemed little enough to ask. I became obsessed with the idea of getting the damned thing to give me such a reading.

So I just started chucking things into it and switching it on. Pencils, sheets of paper, wire—all disappearing in fine style, but never for only 1/10. I finally tossed the remains of a sandwich onto the board and punched the button with a violence that caused my finger to ache the next day. Then the whole room came apart.

The liverwurst-on-rye vanished, and there was the usual tiny *crack* of displaced air, but this time it was followed by a loud and continuous *whooshing* noise. The room almost instantly looked like it contained a miniature tornado. Papers, notebooks, computer readouts, even small tools, were rushing wildly about in violently eddying air. The lighter stuff, mainly papers, was flying toward the machine and disappearing as it hit.

I felt as if I were in a wind tunnel. I grabbed a bench for support, but my hand slipped and I fell to the floor, landing hard on my right elbow. A glance upward into the chaos of whirling debris showed me papers and shreds of papers appearing in various places around the room. I tried to pull myself to my feet, but my arm hurt like hell and I fell back groaning. A window blew in with a crash, and fragments of glass shot over my head toward the machine.

I couldn't even begin to think what was happening. I just kept on trying to rise. Finally I got more or less upright, using one arm, and staggered to the machine. Actually I had no choice. My upper half was being sucked in that direction. If I hadn't forced my feet to follow I would have fallen over again.

I was fumbling frantically at the switch, dimly aware of Randy's voice yelling somewhere, when a sharp pain in my bad arm alerted me to the fact that it was being pulled into the unit. Too weak to resist, I lost my balance again and fell forward. I felt a lancing pain along my forearm and saw my sleeve come apart and flap loose in the rushing air. Screaming in fear, deafened, blinded by tears, I stabbed at the button once, twice, then a third time just as I toppled completely. The machine died and I fell head-and-shoulders across the board.

I lay there panting and gasping and hurting. I heard the door bang open. Then I felt Randy's firm grip easing me to the floor. I sat there bewildered, trying to answer his stream of questions. Suddenly he stopped short and said, "Jesus, Lou, your arm!"

I nodded. "Yeah—yeah. I fell on it. Think I—cracked—elbow."

"No, not this, man; this was no fall, look!"

I looked down at my tattered sleeve, turning my arm gingerly as far as I could. A six-inch-long strip of skin from my inner forearm was—gone. Sliced cleaner than a Christmas turkey. And I was bleeding like a stuck pig.

Randy helped me to my feet. "C'mon," he said. "Gotta get you to a doctor. Worry about what happened

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later." According to him, he then slung me across his shoulder and carted me upstairs, where he called an ambulance. I couldn't say; I passed out cold.

The elbow was cracked, but not badly, and the wound wasn't deep. They soon had me all packed, sewn, bandaged, and cast, if that's the word, and sent me home. But I didn't stay there long. First thing in the morning Randy and I were on our way to Keane's office, and the throb in my arm just served to make me even madder than I already was.

Unfortunately what I said earlier about brute force and machines applies to corporate machines too. Much as I wanted to pull one of those scenes where we'd bull past all the guards and barge in on Keane, we had to obey the laws of company mechanics and get our little badges and wait our little wait. Finally we got in. Keane saw instantly how furious I was. I started right in:

"All right, so since when can one of those things fire continuously?"

"What the hell—"

"Answer my question!"

"Hey, now take it easy! Yelling won't get us anyplace. Continuously? It'll keep firing as long as you keep pressing the clip button—"

"I didn't say repeatedly, I said continuously. A steady time projection, sending the air in the room into the future, non-stop. Like a goddam vacuum cleaner. And a piece of my arm with it!"

"Jesus!"

"Yeah, him too if he'd been there. So how about it?"

"It did that?"

"Bet your ass."

Silence. Then, "Well, a modification could be made that would accomplish that, keep the generators firing at the crystal indefinitely. But without that, no way. And no one with half a brain would do that. It would be very dangerous. Uh, as I guess you know."

"You mean this has not happened before."

"Mp-mm."

"And you don't know of anything in your unit that would cause it?"

"I said, no way. You've discovered something new again, it seems."

"Goodie for me."

"Okay, look, I'm as much in the dark as you are. Let's get out there and take a look at it." He grabbed his coat and headed out the door almost as briskly as we'd come in.

On the way I described the whole scene to him and we doped out exactly what had caused the phenomena I observed. The machine sends air into the future, and new air rushes in to fill the gap. In this case, the new air was in turn projected as fast as it arrived. It became a continuous process. And since the air was intangible with respect to its surroundings, it behaved like air in a vacuum, shooting off in all directions, trying to distribute itself throughout all available space. This created the hurricane.

But the air was sent ahead at many different intervals. Some of it didn't rematerialize until it had gone right through the walls and ceiling. As air pushed air, the whole thing accelerated. So the machine acted as a vacuum pump, sucking everything toward it and imploding the window. We were lucky the walls didn't disintegrate. There was

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actually a hole blown in the ceiling over the machine.

The paper was interesting. If it got sucked in fast enough it remained intact. But some of it got projected piecemeal and ended up in shreds. Reappearing at various levels, it got blown all over the place. We found some upstairs, some in the yard. Pieces of my sleeve we found in a corner. We didn't find the slice of my arm, thank God. I assume that, following the dictates of gravity, it received a decent burial.

Keane was appalled at the wreckage. Some of the equipment he had loaned us had been damaged. But he dismissed it rapidly and started to pull the unit apart. At one point he began to mutter excitedly about the possible practical utilization of time machines as vacuum pumps, but I cut him short with the dirtiest look I could muster.

He found the problem easily enough, and it was just what he had supposed: someone had made a deliberate modification. It sure hadn't been Randy or me, and supposedly no one but Keane and his crew even knew we had the thing. I felt a chill that wasn't entirely the March air coming through the busted window.

"Look at this damn thing," Randy was saying. "It's made to stay on continuously only when this little plastic pin under the button gives way after it's been used awhile. Then it depresses fully and catches. That's why it worked okay on your first few tests."

"Maybe they were hoping we wouldn't be able to pinpoint the time the replacement was made," said Keane.

"A hope fulfilled," I said sourly. "Who are we talking about when we use the word 'they'?"

"Either the U.S. government or the other guys, and the latter is the only real likelihood."

For a moment I thought he meant a foreign government. Then I realized. "Holy good Christ, you mean Time-Techs?"

"You got it. Obviously they are indeed, as I said, on the same trail as us. Also obviously, their intelligence beats ours all hollow. They know we've got it while our own company doesn't. How's that for irony?"

"Which means," Randy said quietly, "that it's not your blasted company fighting Techs. It's us. Just our little not-so-secret-as-we-thought group."

"Correct."

"Oboyoboyoboy," I said. "We are, in effect, the big-shot idealists, fighting both the major corporations in order to beat out the military. Ah. Well I'd just like to go on record as saying I hate it."

Keane looked suddenly puzzled. "Wait a minute! Why didn't they steal the crystal?"

I shrugged. "Because I came in just as they were tinkering with the unit and scared them away? Because their mothers taught them not to steal? Because Lassie the wonder dog surprised them? Look, how do I know why they didn't steal the goddam—"

"Because they already have one! Yes, they already have one. That's got to be—"

"Then why the sab—"

"Because they want to get there first of course, and they don't have to steal from us to do it, they just have to *stop* us!" Keane was on his feet, pacing

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frantically. "I don't know whether they wanted to wreck the unit or actually kill you guys. I guess both or they could have just smashed the thing. Whatever, the point is they know *it's* here, they know *you're* here, and for that matter they no doubt know we're here right now." He started gathering up papers from wherever they lay. "We've got to move you and your work someplace else."

I never even considered not contiuning the work. I avoided admitting the main reason at the time. I wasn't being an idealist, you see. It was the action now—the excitement. Adventure, they used to call it. Aside from that, I liked time machines, and to have a shot at advancing the technology . . .

But there was a still more immediate reason. I was mad. I could have been mad at Keane for getting us into this, but hey, I had free choice. Nope, somebody had damn near done me in, and I was pissed: simple as that. All the more so since they were faceless corporate spooks. The Yankee independent in me bridled at that.

I assume Randy felt the same way; we never discussed it at the time. It made absolutely no sense, trying to fight some big outfit, which was probably why we didn't allow ourselves to think about it much. We should have come out in the open. Chucked the whole thing. The Pentagon would have been overjoyed. Keane and crew would have had at least a partial victory. Time Designs would have come out on top, time machines would have become part of the arsenal of defense, and we would have been safe. Ah well.

We closed up our shop and called it a vacation. Keane took us and the machine and whatever papers we could salvage by some devious route to an old garage out in the sticks that he had used as a lab in his own tinkering days. The place belonged to his grandmother, a nice old sort who couldn't care less what he did there. Keane's assistant brought us what remained of our equipment plus replacement items.

Some vacation. We tested full time now, and more than full time, with a sense of urgency (read "panic"). All the while we expected the stock melodramatic things: news of our old shop being bombed; strangers asking questions in the nearby town; Keane's grandmother being harassed. But none of this happened. We began to feel relatively secure and able to think of the long-term problems. Like, what to do when we did get a handle on this thing?

And we seemed to be doing just that. Randy and I had been tinkering with the generator, changing the light and sound combinations. We had a pile of data which Keane's people were very excited about. We even had the satisfaction of filling in that damned 1/10 of a second, plus lots of other times. We were, in fact, learning to control the thing.

Two weeks after the move our load was increased by half. One guy in each of the other two teams was married. (Randy and I were bachelors.) They had been moved to secret locations too, and couldn't take the separation, not to mention the worry about danger to their families. Keane had decided against taking any new people into our confidence, so the remaining two guys teamed up. We split the work with them.

The new work actually made things

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crash, since it gave us that much more data. Our progress sped up enormously. After a bit less than a month it became apparent that distribution of impurities was the controlling factor. The more regular that was, the more predictable the projections. Type of impurity determined the actual time spans. A crystal could be made to project in tenths of seconds, or multiples of powers of two, or whatever. So by mixing types precisely and making regularity of distribution near-perfect, it was possible to cover virtually all time spans and predict the shots with nearly one hundred percent accuracy. Theoretically.

But we were a long way from that. These advances were just statistical. We could determine the multiples, and predict with much greater success. Controlling a particular projection, however, seemed as far away as ever. It wasn't good enough to know how often in a series you'd get 8.10 of a second and how often you'd get 77.6 days.

As it turned out, the breakthrough was to be dented us by two circumstances which occurred on the same day. A lovely day, otherwise late May, just warm enough, early country evening coming through the lab windows in the form of bird sounds and lilac smells. Our antagonists chose this moment to strike again, this time putting themselves on the line in an attempt to get us.

Randy was working with the machine itself, while I was at the computer. He had the cover off the works of the unit, having just switched crystals, and had turned it on to check the hook-up when we heard the door open. We both turned. We expected Keane's grandmother. She was the only one who just walked in; Keane and his assistant always knocked.

Confronting us were two guys of frighteningly average appearance, silent, both with guns in hands.

Now in any spy flick I'd ever seen this was the point where the bad guys made fools of themselves by talking up a storm, gloating, giving away all their plans, thus allowing the dumb hero to come up with some clumsy defense or other. Being a realist I knew these guys were no fools. I found myself wondering whether I would have time to hear the shot. (I've always wondered about that. I still do.)

But Randy was a realist too, and not at all dumb. He knew as well as I did that we were dead men, that we weren't about to talk our way out of this. He reacted; picked up the first thing handy and threw it right at the two clowns. The first thing handy was the time machine.

I had a freeze-frame impression of two astonished faces. Then one guy ducked to one side. The other one reflexively threw up his gun arm to ward off the flying object. He did; there was a clunk, a blue flash, the usual *crack* of air, and a scream of pain. The machine crashed to the concrete floor, along with a revolver and some bloody fingers. They were followed by the howling and struggling form of the gunman, his right arm missing from midbiceps.

I hesitated a second, which nearly cost me but good. Then I heaved all I had at hand, a thick sheaf of print-outs, at the other one. He got off a shot from his crouching position. The slug zipped

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through the cloud of paper past my ear and hit the wall. Then Randy was on him, kicking his gun arm so hard it broke. Randy and he both yelped in pain, as Randy's instep nearly cracked. The gun landed in front of me. I picked it up and covered the bastards.

Randy was crazy with adrenalin and rage. "That's for your arm, Lou!" he screamed at me. "Two for yours!" I was trying to hold my stomach down at the sight of the first guy bleeding all over the floor. He needed help fast, so I got my attention off him and onto calming Randy down. Actually I didn't care all that much whether the schmuck bled to death or not, but the activity took my mind off my stomach.

I can't recall who Randy phoned first, Keane or the ambulance. The ambulance arrived first, however, and the small-town crew did a double-take at the sight of those guns. Not the injuries; they'd seen worse on a dozen farms. They called the police, naturally, and neither Randy nor I was on top of it enough to invent a decent cover story. So we told them the truth, omitting the fact that we knew perfectly well why we'd been attacked.

"Okay," said Keane, who'd had the good sense to wait till the cops had departed before arriving. "We have two worries. One is that those guys might talk. At least then their employers will be nailed, but it'll still put the kibosh on our scene. Two is that the cops took the whole damn machine as evidence. If the lab boys find out that crystal's different—"

"The crystal's busted," Randy said.

"You sure?"

"Mm-hm. Checked it before they got here. Three pieces."

"The whole machine was a wreck," I said. "You don't think they'll analyze the crystal?"

"Not unless they notice the slight color difference," Keane replied. "And then, if it's unusable, what the hell?"

"Anyway we're out of business here, I guess," Randy sighed.

"For sure," said Keane. "But it may not matter that much, guys. I was just leaving to come tell you when I got your call. The other team's had what looks like the breakthrough."

Randy and I looked at each other. We were too tired to get excited, but our technical interest was roused anyway. I spoke first: "You mean they can control it? Predict on a one-time basis?"

"Looks that way. Niney-six times out of a hundred, in a series completed just this morning. No miracles or surprises, just a complex series of generator firing-time interrelationships. They worked out a set of tables on computer. We'll need a more sophisticated firing mechanism before it can be done outside the lab. But that could be developed in a matter of days, could be in production in a couple months. Hold it! Before your mouths even open. I know you want to hear all the details, and forget it, because there isn't time now. We've got to hide you and the remaining crystals. Tonight."

"What about the other team?" Randy asked.

"We'll probably move them soon, although we have no indication they've been found out yet."

Randy and I exchanged wry grins. "Some bastards have all the luck," he said.

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We did have our share of luck: no one spotted the difference in the crystal. We also came out on top with the two crippled creeps. They never talked. The pressure on them from above must have been fierce. As a result they would likely get the maximum for armed assault and/or robbery, not to mention illegal entry. We were also hoping for intent to do something-or-other. But nobody could prove what they intended to do, so there it was.

Keane had us in another state now, on an old farm he bought up practically sight unseen. Similar to his grandmother's but not so comfy. She had treated us like relatives—welcome ones, I mean. Here we had to fend for ourselves. Plus we had to get our carpentry act together to put the old barn in shape.

Soon after we got back to work the other team joined us. One of them was a little Pakistani named Jay-for-short, or just Jay, for short (so help me, that's what he said). The other was a likable, talkative guy named Tim who was what used to be called a "hippie-type".

We were off research now, all of us developing the new firing mechanism. Keane brought us an industrial unit, a biggie used for cutting pipe. He had it in mind to develop a machine that could send a human through time.

I thought a lot about those NASA types of mid-century, guys who spent their childhoods gazing at the moon, reading Bradbury, and watching Flash Gordon. Then they found it all coming true in their own lifetimes, and they themselves the ones doing it. I guess I should have felt the thrill and satisfaction they must have. But I didn't.

For one thing I had come to time machines fully grown. But more than that, I was preoccupied. With what? Fear. I was scared stiff most of the time now. I had dreams of evil-looking dudes doing us in in bizarre ways, and twice I dreamt of a huge mouse with no back end chasing me with a carving knife. (Don't ask me how a two-legged mouse carries a knife, it was a dream.)

I guess Randy felt a lot of that too. He was very quiet and sober during this period. Hard to tell what he was thinking. It didn't affect Jay or Tim much, though; they hadn't been through what we had. Tim was certainly no way quiet. He talked all the time. He loved gadgets as much as I did. Happy as a clam, tinkering away. He kept up a nonstop rap about what we were doing, how hard it was to find any women in town, and how he intended to be the first volunteer to time-travel. Jay would listen to him, look at us with a lopsided grin, and shake his head. He hardly ever spoke. They were nice guys.

Finally we had the mechanism, and we began testing once again. It was frustrating, since in spite of the size of the machine we didn't dare send anything large. We could have caused an earthquake. As it was we produced tremors on two occasions, scaring ourselves shitless.

It soon became clear from our results that what we sought was possible and that we were on our way to attaining it—sometime. Speed was not one of our results. Tim joked that if we had the thing perfected we could travel ahead in time and ask ourselves how we'd done it. Jay startled us by seriously suggesting that we go ahead and try the machine on one of us.

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The suggestion surprised me in two ways. First, it told me that under that bespectacled, grad-student exterior, Jay had as much sense of adventure as any of us. Second, it made me realize that we were coming to accept Keane's notion of human transport. His influence on us was powerful or we wouldn't have been there in the first place, making Time Machines for Peace. He talked up his feelings so strongly and so often that we sort of soaked them up.

I began to think, really for the first time, what would happen when and if we got this thing to its ultimate testing stage. Or, rather, to whom it would happen. Once I realized there was no way to think in the abstract of sending a person, it followed that a particular person would have to be chosen. And who could it be but one of us?

One night in July Randy and I sat on the stone wall outside the barn, talking. It was a sweet night. Randy had been in that quiet, sober way all day. It seemed to me by now that it was something more than just the danger, the fear. The rest of us could at least manage to loosen up and relax in our off-hours. Randy didn't seem to be able to. So I asked him straight out what it was.

For a minute he said nothing. Then he closed his eyes and rubbed the side of his nose a couple times.

"Lou, does it ever seem to you like it's all useless? Like what's gonna happen, good or bad, will, no matter what we try 'n' do?"

I gave him a sure-but-so-what? kind of shrug. "Yeah; I mean, whoever's gonna be the next president will be whether I vote or not, I know that. That what you mean?"

He frowned. "No. I mean yes, sure, but I'm talking about every day. What we're doing right here. For instance, any four—uh, six at first—technicians could have done what we have. Somebody at TimeTechs obviously did. This may all have the feel of the old adventurous, lone-eagle type of inventor drama. But no one's had any brainstorms. Just compiling data toward an evidently inevitable end. The discovery of the original impure crystal was an accident, a slip of quality control."

"Okay," I answered. "True. But maybe Keane couldn't have found another bunch of guys who would have gone along the way we have. It took some doing to find us, after all. We have a reason for doing this. I kind of like us for it," I said piously.

"Mm-hm, and what's our reason?"

I tried to choose the right words, to say it precisely, because I sensed that he was going to play one of those question-and-answer logic games. I do it myself, and I wasn't about to be talked into a corner. I spoke slowly. "Unlike instances recorded time and again throughout history, we have seen the potential for both good and harm in a new discovery before it becomes a complete and finished reality. And we are therefore making a conscious effort to direct that discovery in such a way that the potential for harm may be minimized or even avoided. And, hopefully, the potential for good realized." Any logician or deep grammarian could probably poke holes in that pretentious mouthful, but I didn't think Randy could. He didn't try.

"True enough. A very fancy way of saying we're trying to be heroes." I

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opened my mouth to protest but he cut me off. "All right, all right. Good guys anyway, who have some crazy hope of keeping a dangerous toy out of the hands of the military people. Who would no doubt argue that we were denying our country a defensive advantage."

"For sure. But when has any new defense development remained in one country's hands? For that matter, what would happen if it did?"

Randy nodded. "A weapon is a weapon. It's designed to hurt people. So here we are trying to keep something from becoming one. And as you said, to find a better reason for its existence." He shook his head slowly. "But it's no good, Lou. It's inevitable. A thing *is* a weapon, it doesn't become one. Look: what's the only new practical use made of a time machine since Keane first put the impure crystals in?"

I gave him a blank look. "There hasn't been one."

He shook his head again, firmly. "Wrong. Down at the local police archives there's one of the three original new models—or what remains of it. And it was used as a weapon. By me."

"Nah—" I frowned with scorn, or maybe disgust. "Come on! You *threw* it, for Chrissake! It happened to be on. It could have been off. It could have been a paperweight!" He looked exasperated. "Look, Randy, I threw computer printouts: you gonna tell me they're a weapon, was that the first new practical use made of them?" I got so worked up I didn't take a breath, ended up squeaking at the end, which made me even madder.

"No good, you lose. You didn't hurt anybody with 'em, and couldn't have." His face took on a sarcastic look of revelation. "Lou! You invented the first true *de*fensive weapon!"

I gave. "Okay okay. So you hurt someone with it. But it *was* in self-defense." I said lamely. "It was their fault. You gonna start a war, you gonna get burnt."

"Also no good. Who started the war? I mean, I don't know. They had only one reason for being there and that's the machine itself. Not a paperweight. And we had the machine. Whatever. Weapon or not, it was already a cause of harm." He gestured towards my arm, still in a cast. "And I did make a weapon of it. And it did do harm that a paperweight could not have done."

I was silent. I didn't agree with him, but I think I was just being stubborn. Or more likely I didn't like to see him hurting himself. At any rate I couldn't out-argue him.

After a time I said: "So that's why you've been so uptight lately?" He nodded. He got to his feet, stood with his hands in his pockets, looking out over the dark purple hills.

He kicked at a stone. "It's all wrong, Lou. Do we know all these other people of Keane's? Do they know us? What about when we go public? Who can trust who? What's this stuff Keane mentioned way back when and hasn't seen fit to trust us with, about finding things out in space? No good. I tell you if it *can* be used for harm it will."

I was beginning to feel pretty depressed. "So what are you saying? That we should quit?"

He flashed that wry grin, more like himself. "Naah. I don't know how.

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And I love this work, despite my current gloom. And I also don't feel any particular sympathy for that gun guy. Which makes me feel guilty." He sighed helplessly.

I got up slowly, brushed off the seat of my pants. I looked him right in the face. "We've got to go on. No; let me amend that. We *will* go on. You know we will."

We started back to the house, ambling along with our eyes on the ground. Finally Randy said, "I just think—you're right, of course—I just think we may have to go in a somewhat different direction."

"Such as?"

"More toward human transport."

"Keane will love you."

He snorted. "Yeah, he's more pushy than us. Conservative research scientist indeed. But all this cloak-and-dagger stuff—which I admit hardly seems to pervade our lives these days—it may be we're going *too* slow and careful, too scientific method, y'know? Maybe we should take more chances." He paused. "It's gonna take a lo-o-ong time to compile tables on all the variables, and they'll need the quality control available only in the plant to produce the crystals and generators. To be safe, we shouldn't send a human until all that's been done. Inescapably, we'll have gone public first, patenting and publishing. And what is the opposition doing, I wonder?" He stopped walking and faced me. "Do you think they'd have any scruples about the dangers? Hell, they may even be far enough ahead in their thinking to figure out a way to use the machine itself to assassinate us."

"That, they already tried. Now I check the damn thing every day."

"No, I mean their own machine. Look, if they had it down to where it *was* controllable, or even nearly perfectly predictable, they could use it to strike at us in its proper capacity as a time machine, couldn't they?"

"Uh—don't follow you." We started to stroll again. It was about fully dark now.

"I thought of this just today. Actually I was thinking how a time machine could be used for a political assassination. You see? Even a peaceful genius like me, corrupted into dreaming up violent applications. Well. Suppose you know the president is going to make a speech at such-and-such a place, on Wednesday next. You know where the podium will be, you know the approximate time. Close enough that you can safely fix a point during the speech, anyway. So: you go there late at night, no one around, set your damn-near-reliable time machine, point it at the podium, aim your gun into it, and fire a bullet into the middle of next week."

I couldn't believe it. "Jesus." I felt a chill. So logical. So easy. "That's so subtle you're sick."

"Very likely. But the point is a lot of people are. Some of our opponents evidently are, and all they'd have to know is where we sleep and at what time."

"Oh, Lord . . ."

"And what's our defense? The classic defense against guns is guns. Someone shoots at you, you shoot back. The classic defense against bigger weapons is warning: radar, alarms, and such. What's the defense against a time machine? Run and hide?"

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I got a sudden feeling that our recent sense of security had been a symptom of dangerous naivete. I also got an instant conviction that Randy was right about taking more chances. Had we been working urgently up till now? It should have been desperately. "Come on," I said, starting at a brisker pace for the back door of the house. "Let's talk to Jay and Tim. Then let's call Keane on the scrambler. Then let's not go to bed."

Keane didn't take much convincing. The next morning saw all four of us out doing the carpentry bit again, this time building a platform on the barn roof, overhanging the end above the hayloft doors. We had it done by late afternoon and hauled the industrial unit up with block and tackle. We had decided to abandon the test series we had been working on. The hell with compiling complete data. Now we had enough room to start sending large objects for short spans.

Having our goal finally stated—"We will aim towards human transport"—was like an adrenalin shot for all of us. Tim talked like a speed freak. We wanted to start right away, but darkness came on and we had no way to light the area. Tired as we were we sat up late, too nervous and excited to sleep.

The next day we hauled some old oil drums up on the roof and began. It worked well, with a high rate of predictability from the first. It was really weird seeing those barrels materializing at various levels above the ground and dropping with a clang to the dirt below.

We only used one crystal, trying to get as predictable a series as possible. It was our best crystal, the one with the most regular distribution of impurities. We had a reliability factor of ninety-seven percent within two days. None too soon; we were all getting more nervous and tired with each succeeding peaceful day. Coupled with Randy's little fantasy, the peace was driving us nuts. I think we would have liked to have the opposition try something, just to relieve the tension.

Our wish was granted, but not at all in the way we expected. Keane arrived in the late afternoon and told us he had been approached with a deal.

"Standard stuff. They want to buy us out, give us a fat percentage while retaining the rights themselves. The threats were implied. Bigger and better hassles if we refuse."

"So you told 'em what?" asked Tim.

"That I'd have to ask the rest of my people. Which I did, and am doing."

"What'd the rest of 'em say?" Randy inquired.

"What do you guys say?"

We all glanced at each other. I looked back at Keane. "Uh-uh. The money means nothing, since if we win we'll get that and more. So really all they're doing is continuing to threaten us. That's the problem we have to deal with."

"They must know where we are by now," said Jay.

Keane nodded. "I suspect they do. That's probably the message they intended the threats to convey."

"And so we have to move again, or fight back, or get ready to come out, or something," said Tim.

"You haven't told us what everyone else said," Randy reminded.

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"Oh, same as you of course, me included. No question there. Thank God. Dissent would be a disaster."

We all stood around and sort of shuffled in place for a minute. Finally Tim, who shuffled faster and was through sooner than anybody else, turned towards the barn and said to Keane, "C'm'on, we'll show you where we're at." We turned and marched off into the building.

Keane was impressed. Aside from our percentage of successes, our few failures had all been of spans which were under the time taken by a barrel to reach the ground. We had calculated dangerous failures as statistically predictable, but we hadn't had one yet. Had we sent a human, he would have been safe even if a misfire had occurred. We did a quick calculation and found our up-to-date percentage of safety was ninety-eight point five.

We looked around at each other and I saw the same expression on every face. It must have been on mine: satisfaction combined with apprehension. I tried to tell myself I was still worried about the enemy, but that wasn't it at all. We were safe until Keane contacted them to refuse their offer. No, what was going on was that we all knew what someone had to say, and we were each afraid to be the one.

Randy took it. "Send me."

Nobody was clumsy enough to act surprised. We stared at him. "Randy," I began. Keane interrupted.

"You sure, man?"

He nodded, lips set tight. "Randy," I said again. "No one really knows what kind of side effects the radiation might have on a human. You could go through safely and still get done in by it for all we know."

"Living things have been sent and survived, you know that."

"Yeah. The front half of my mouse was as alive as the back half." Nobody laughed. I felt stupid. "What I mean are controlled tests. No one has sent an animal and then studied it over an extended period."

Keane broke in. "He's right. No scientist would say we were anything but crazy. And never mind science—the law! If anything happens it's probably manslaughter or something. Even a safe test may be illegal for all I know."

Randy was impatient. "You know as well as I do that we've intended to do it all along. If we thought we were gonna wait till we had perfect tables we were living in dreamland. There's just no time." He flashed a grin, more like my old partner. "Possibly no space either."

"Okay," Keane said. "Granted, but why you? Shouldn't we draw lots? I mean all of us, lab boys included."

"Get real! You just agreed we're up against it for time."

"All of us here then." Randy protested that since he had volunteered there was no need, but we overruled him. Whether out of fairness or our own individual desires to be the one, who knows? We drew then and there. We opened the slips of paper. Randy won.

He guffawed, completely tickled. "Fatesville."

"Randy, are you sure you're not eager to do this just because you're feeling guilty?" I asked bluntly. The others stared at me sharply, but this was between the two of us.

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Very quietly he replied, "It doesn't really matter now, does it? And I guess we'll never know. Come on." He turned and led the way outside.

Randy was eager, but we had to set up precautions first. We dug a pit three feet deep and packed it with hay to ground level, to produce at least a semi-soft landing. The sun was just going down when Randy and Jay climbed to the roof.

With Jay still on the ladder, Randy called down, "There's one barrel left up here!"

"Send it through!" Keane yelled back. "One more test can't hurt. Check out the hay." Randy didn't answer, just rolled the barrel onto the platform. He set the unit, turned it on, stepped back and pushed the button. There was the flash, the crack, then what seemed an agonizingly long interval.

Right on the hay pile came a blur of green barrel. Then there was a hell of an explosion, and hay and dirt and sharp stinging flakes of metal sprayed over us. I yelped. Keane and I hit the dirt.

When the dust settled there was hay all over the place. The top two-thirds of the oil drum, sliced raggedly, sat on the ground ten feet away.

We had had our first dangerous failure. The damn thing had gone too long. The drum had materialized inside the hay, and they'd both disintegrated with a bang. I stared at the remains of what would have been Randy. Then I looked up. I swear I could see his pallor from where I was.

In the stillness his voice drifted down, calm and quiet:

"Good. Makes the odds better."

No one else spoke. The three of us replenished the haystack. Then we stood away from the pit and glanced upward. Randy hesitated only a moment. Then he stepped to the platform, squatted as if he were going to jump, and nodded back at Jay. Jay checked to make certain Randy was completely within the firing zone. He clapped him on the shoulder once, stepped back, and turned the thing on.

There was deep silence except for a woodpecker who produced one fast series of raps in the big dead maple by the barn. Then Jay pushed the button.

The blue flash, lurid in the twilight, accompanied by the loud crack, made us all start. An instant's wait—and Randy appeared, the height of a tall man above the haypit. He dropped into it, rolled, and sat up with an astonished look on his face.

For a moment nobody did anything. Then Tim leaped into the air, shouted "Yee-hoo!" and ran over to Randy, who now wore the granddaddy of all shit-eating grins. Tim practically hauled him out of the pit, pumping his hand and jabbering. "Wow, man, you did it! Yeah! What the hell! Did it! Another Gagarin! A—a—Neal Armstrong! Who, Jesus, I dunno—wow!"

Keane and I arrived at their sides. "You all right, man?" I asked. Randy nodded. Keane beamed. Randy smiled at all of us, then tipped his head back and stared upward, mouth open. Jay lay on the platform looking over the edge at us with a smile like a searchlamp in the twilight. Randy waved broadly. "Hey, Jay!" The little man disappeared, scrambling down the ladder a moment later.

"What was it like?" asked Keane as

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Jay ran up. Randy and Jay slapped each other on the back.

"Absolutely instantaneous. I was there, then I was here. Like a dream. No sense of space or duration at all." A wondering look came into his face. "Brief as it was, I lived through that time faster than you guys. Do you realize that? Is that incredible? I mean I practically skipped it entirely."

I glanced up at the roof again. No doubt recognizing that this was a historic moment, I made the most immortal pronouncement I could: "Shit!"

A few minutes later we sat in the house over congratulatory drinks. We kidded Randy about looking younger than he should. He laughed more than I'd heard him in months.

We sobered up soon, though. Our next step had to be decided. Keane would reply to the offer the next day, and we had to get out of there. Three choices faced us: test further, go public, or—hardly likely—defeat the opposition.

"What I'd *like* to do," said Keane, "is try a much longer test. Minutes, hours even. Something that would *really* justify our calling it a time machine. Prove it more useful than for getting people down off roofs." Tim cackled.

"Yeah but," I objected, "what are you gonna do, drop someone from an airplane? They'd be killed; can't use an intangible parachute."

Keane shook his head. "You're not thinking high enough. I propose to dispense with the gravity problem entirely."

"Space," Jay said.

"Exactly. A commercial shuttle flight, probably about, oh, $5600 base, then more because it'll have to wait for the reappearance. We'll supply our own computer calculations, save money there. You realize the new danger involved here?"

I said, "Yeah. The shuttle either has to be kept in the precise orbit of the time of sending, or return at the time of reappearance to the correct spot. And even then there could be orbital drift on the part of either subject or craft."

"Ri-ight. He could, in other words, reappear in vacuum. Still, he shouldn't be so far off that we couldn't pick him up. He'd be wearing a suit of course.

"But I wasn't thinking of that. The company does flights regularly, so the mission in itself won't be suspicious. And I think we can wangle a pilot I know who can be trusted. But the co-pilot will be a sticker. We may be forced to take an unknown quantity into our confidence."

"There's no way we could just keep the real nature of our mission a secret?" Tim inquired.

"Not from the flight crew. We're gonna have a guy go up and come down again who's nevertheless missing for most of the trip, Tim."

"Oh. Yeah. Sorry."

"For the ground people, no sweat. We'll take up and let off a dummy satellite and give 'em some bullshit about having to take readings later from a different angle. That'll account for the wait."

"Well, it sounds like there's no way but to risk bringing the flight crew into this," I said.

"Whoa," Tim exclaimed. "How about telling 'em this is one of your classified jobs? Might make 'em less

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curious. Even if they did figure out what you were doing, they'd think it was government stuff."

Keane looked surprised; then he threw back his head and laughed. "Fantastic," Randy said. "Tim, you've got a lotta balls."

"Uh, well, a lot, I—"

"Okay, yeah, great," Keane said. "Next problem is getting the machine on board."

"Taken down and packed with the satellite," Randy suggested. "A little size and weight fudging. That's the nice thing about these pet gadgets of ours: they're mostly air-space."

"Sounds too easy," I complained. "How long to get a flight? How long to check somebody out? I mean two people have to go do this thing. I assume you—?"

"Right. I'm checked out. I'll operate the machine," Keane affirmed. "One of you will have to be given basic training and get checked out. Usually it takes about five months to get a flight. We have pull, so we can cut that a bit, especially if someone cancels and we shove our way to the head of the line. However long we have to wait, that's how long we'll have for one of you to prepare. Crash course. Mean a lot of work." We all looked back at him willingly. "Okay. Then that just leaves questions of how long the flight will be, how far ahead we can send, and where the pick up will be made. Computer stuff."

"That's not quite all," said Randy. "Who's the cargo?"

"Well. I wish I could be, but I'm not in as good shape as you guys. Paunchy lab-sitter and all that. Really, I think the weight consideration settles it. The smallest."

Everyone turned and looked at Jay. He grinned that neon grin of his and shrugged. "Sorry, men."

"Wait a minute," Randy said. "I don't mean to be nasty or anything, but I think Lou should get the chance. Not just 'cause he's my friend, I wouldn't do that. But he's earned it." He nodded towards my arm. Jay's face showed disappointment, but he nodded in agreement.

"On the other hand, I'm the youngest, and Randy has experience," Tim said in a mocking tone. "How 'bout we draw again, so nobody hates anybody later, huh?"

"Right," I said. Keane brought forth the slips of paper and dumped them in a pile on the table. We all drew, we all unfolded. I got it.

"Oh well, maybe when I'm older," Tim said.

I looked at Randy. "Two firsts in one day," I said. "Never knew anyone who could fix two successive drawings of lots before."

It took three and a half months. Keane got the other guys to a new hideout. God knows where. "Don't let your right hand know," he told me. I had it easy, training all the time. The others just about went nuts from boredom. Leave a technician cooped up with no work to do and you run a severe risk of unleashing psychosis upon the world. Leave three of them together and you invite homicide. They finally started rebuilding all the appliances, making them better than their manufacturers would have approved. Then they started

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sneaking into town on weekends, carousing as inconspicuously as possible. Tim took up with a woman, which Jay and Randy thought inadvisable, until they found that she kept him from talking their ears off. Besides, had they only been so lucky . . .

Randy and I got together once, for the trial of the two goons. They got a stiff sentence and held silence. We were safe enough in public, and got back into hiding with no sweat.

I can't reveal where I received my training, even the general area. But it was a far piece from any of our other hideouts. Keane's assistant took a leave of absence to stay with me. Evidently the TimeTechs saboteurs hadn't found out about him or the other lab boys. At any rate they were never bothered. We used the government-work cover story on the people training me.

Keane visited us occasionally. During one such drop-in I reminded him of the conversation we had had about time machines as weapons. I mentioned Randy's comment about the classic defenses, that is counterweapons and forewarnings.

"The examples are too modern, Lou. Go back some. What's the classic defense against a sword?"

"Another sword."

"Nope. A shield. Listen, you recall way back when I said some things would eventually have to be found out in space?"

"Mm-hm. For a while there we wondered if we could trust even you, for holding that back. I guess finally I just convinced myself it must be some arcane research project that had nothing to do with what we were up to."

"It has everything to do with it. But it's not the current undertaking. Specifically, it has to do with a defense against time-machine weapons, although I didn't know that it would when I mentioned it. And it's no research project, just more speculation on my part. You probably would not have had occasion to notice it, but a strong magnetic field can affect the crystals."

"Affect . . ?"

"Alter their radiation. And therefore their sending times."

"Good God! Why didn't you tell us?"

"I haven't told anyone. And for now I'm only telling you. I want to keep it from my lab guys a while yet."

"You think one of them might be a plant?"

"I have no reason to, no. I'm just getting more cautious. Or paranoid. They don't need to know, so I'm playing it close."

"And we do? Need to know?"

"Very soon, yeah. In answer to your earlier question, I didn't tell you because there was nothing we could do. We needed predictable machines before we could test ways of altering that predictability. Now we have them."

"What's it all got to do with space?"

"Well, if I could just make a few tests without the gravity factor, get some tables, then we'd have something to feed the computers, so they could make allowances for gravity in Earth-bound tests."

"Can you do that on this trip?"

"Sure. I can use the on-board computer, same cover story for secrecy. Bring an electromagnet aboard in the dummy satellite. I should be able to run

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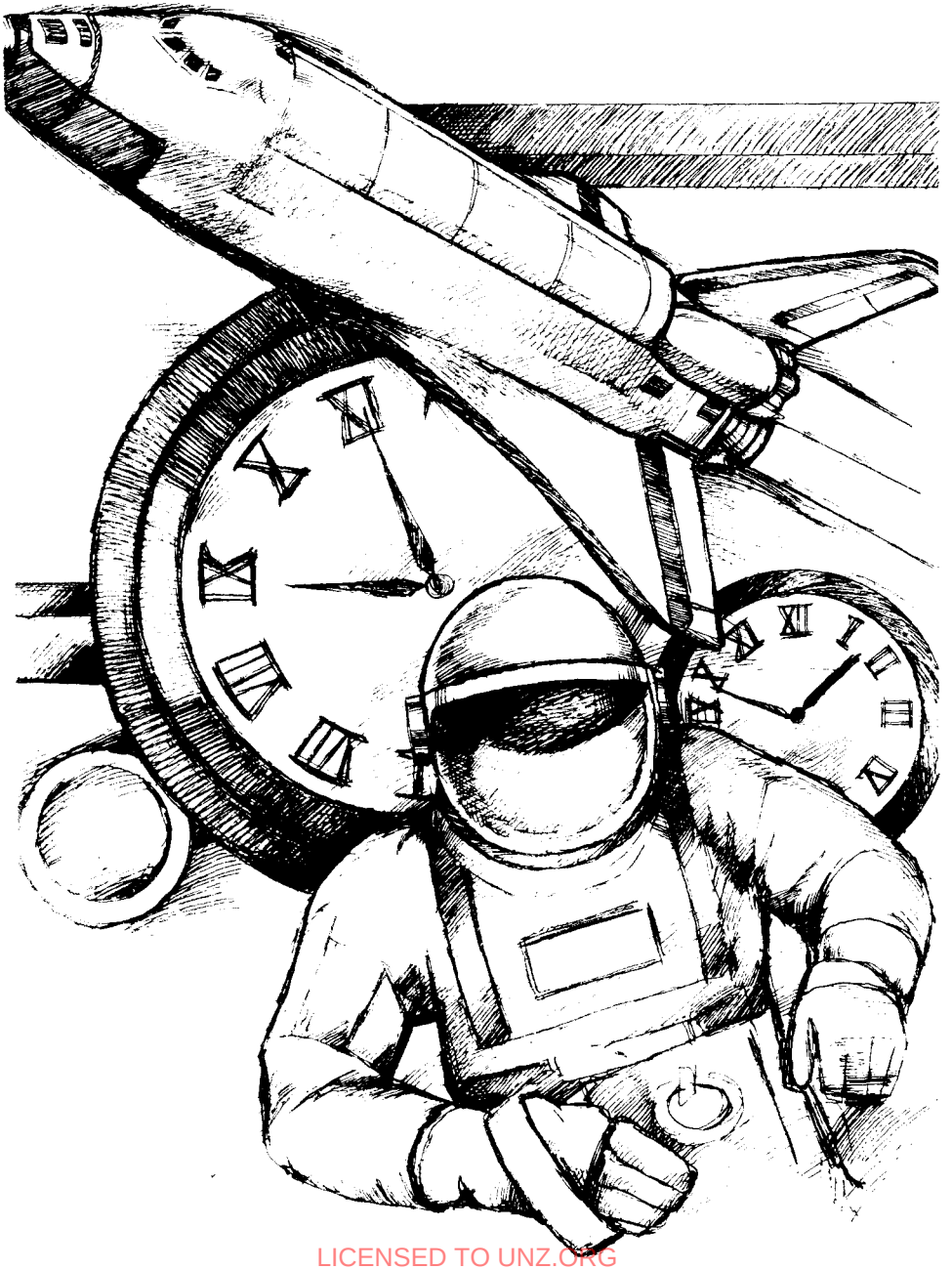

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plenty of tests while you're—ah—out of it."

I snorted. "Randy will be especially happy to hear all this."

"After it's done."

"Hey, this'll mean more of the same, right? Endless testing?"

" 'Fraid so. And in greater secrecy than ever."

"Why?"

Keane smiled sardonically. "Remember what I said about Mother Nature? You can bet if Techs doesn't know about this yet, they'll discover it any minute."

I grunted. "And then what? We start work on a counter-counter-weapon?"

"God, I hope not, Lou. I hope the defenses will cancel each other out and render the damn things useless as weaponry."

I didn't say anything. It seemed I'd heard that before, somewhere.

Keane and I went into space in mid-November. It wasn't that much different from a pleasure flight I'd taken once, except this was longer and didn't cost me an arm and a leg. For all my training, I was really just baggage up to the point where I took my little time jaunt.

That was something else again. We were alone in the cargo bay, both in pressure suits. Keane had put foot holds on the unit to keep me stationary at the moment of sending. A little weightless drift and I could lose an extremity. Like my head.

There was one risk we really couldn't do a thing about: the possibility of emergency while I was intangible. True, for me it wouldn't be long. But for that short period I'd be more alone than any human ever had, with no way to summon help. Nothing outside of myself and my equipment could affect me, however; and there wasn't much that could go wrong with my gear that would kill me in such a short span.

The sending was much like on Earth, except that the vacuum I left lowered the pressure in the hold, a detail Keane had overlooked. His eardrums informed him of the error.

From that point it resembled nothing I could have imagined. I went ahead three days. My subjective feeling told me I lived through maybe a minute and a half. Everything appeared incredibly speeded up around me. Mostly the cargo and the walls remained still, but there was a lot of blur to and from and in the time machine as Keane came and went and performed his experiments. The things he sent became substantial to me for short periods, and would float around in my view before reappearing to Keane and then blurring to me as he picked them up and moved them. Once I played a trick on him by snatching something he'd sent out of the air and gently tossing it behind his seat. But of course I couldn't see his reaction.

That little stunt nearly cost us our lives. The throwing motion caused me to drift toward the hull of the ship. My left leg actually penetrated it. I was afraid it was all up for us. But by twisting and bending I managed to pull back into the open area in time. A couple seconds—it seemed—after that things started to slow down around me. Then I suddenly realized Keane was staring at me with a delirious expression. And that was that. I was none the worse for wear. What wear? I'd virtually skipped

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living those three days.

I helped Keane put out a completely gratuitous satellite. His first real crime-and-act as it turned out he had to juggle the company's books to account for it. [illegible] Either we'd nick the company treasury or we'd all be dead any-[illegible]

We had a big reunion at the other guy's hideout, where we all stood around patting each other on the back.

"Time travel! Wow!" said Tim. "Three days—three years! Why not?"

"And space travel," said Jay.

"Right—space too! In a minute and a half—to you—you orbited the Earth as many times as the shuttle did in three days. Then you, and it, and Earth were in a different place than when you were sent."

"The difference between that and travelling to another planet is just a matter of degree, then," said Randy.

"Well, not quite," said Keane. "Orbital mechanics are a lot easier to play with than interplanetary travel."

"Hell, somebody'll find a way," Tim said. "Something this great can't go to waste."

We went on like this, half-serious and half bantering, for a long time. Finally Keane brought up the magnetic testing. This was the first the others had heard of it. I'll never forget the expression on Randy's face.

"Defense," he whispered. "A defense against their damned weapons. Not a defensive weapon, do you realize that? A shield. An anti-weapon! An anti-[illegible] machine."

We'd seen. With this one could cause a [illegible] malfunction in any time machine: cause it to fall short or overshoot. A missile could fail to reach its destination or even be made to hit a different target. This presupposed one knew of its being fired, true; but one could erect a shield which would deflect generally any attack.

Randy wanted to get busy on it right away. The rest of us waxed enthusiastic, but not nearly so eager. We wanted to make our announcement, patent what we had, emerge triumphant, dicker with Time Designs, sneer at Techs. Sure. Everybody knows that didn't happen. What everybody doesn't know is that there was no way in the world we could have gotten a defensive device operating in time. Not before they got Jay.

The second day after we'd gotten back together had been pleasant, clear and not too cold for November. We were taking a break from discussing the long and complex process of assuring ourselves protection from the defense industries. This would necessarily involve getting Time Designs on our side and willing to lose its current government contracts, a circumstance that would be inevitable once the Pentagon put the screws on.

Every detail of that moment is unnaturally bright and vivid in my memory. I was standing on my toes, arching my back and yawning, when Tim came charging in from the living room.

"Hey! The TV, guys! Come on! It's Techs. We're screwed!"

He looked like he was going to be sick. We got our asses in there. On the tube we saw some kind of press conference, a bunch of official-looking types behind a long table with microphones. And four or five military men

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standing near, which gave me a bad feeling.

"That's Cagianelli, president of Techs," Keane said. "And—Jesus Christ!—the joint chiefs!"

"Shut up!" Randy ordered. Keane did.

"—long and thorough testing which involved all possible safeguards and precautions, although it necessarily remained secret," Cagianelli was saying. "Thus we are pleased to be able to say that time travel for humans is perfectly safe as well as feasible. More than feasible: as has been pointed out, it is an accomplished fact. It will of course be some time before all distances, or rather durations, will be—"

Randy punched the OFF button with an inarticulate snarl.

"I just caught the actual announcement when I came to get you guys," Tim said. "The reporters were going nuts."

"They beat us. They goddam beat us!" Keane sounded on the edge of tears. Randy held his head in his hands; Tim was still shaking. Only Jay seemed calm, if depressed.

I paced. "All right," I said. "All right, let's look at what we've got going for us."

I knew that sounded stupid. "What kinda shit . . ?" Randy said.

"No, no, Randy, really. Look: the bastards have beaten us, and legally. Maybe that's why we haven't had any more trouble from them. They found themselves so far ahead they didn't bother taking the risk. Or maybe they couldn't find us. Maybe they didn't even bother to search. Whatever. They knew they were announcing soon. The lucky part for us is that they waited as long as they did. If they'd announced just a little earlier we might not have made the flight. Then where would we be?"

"Where would we *be?* Where *are* we?"

"In possession of initial tests on a defensive device. Yes? They're selling this thing to the military and we have the way to counteract it."

"Oh, swell. Let's sell it to Russia or the Chinese."

"Let's give it away. To everybody," Jay said quietly.

We stared at him. Then Keane said, "You mean just make it available? To negate anybody's arsenal?"

Jay nodded. I said, "To negate the U.S.'s arsenal. They're the only ones that have it, remember."

"Ten minutes ago we were the only ones that had it," said Randy. "If two companies can get it at almost the same instant why not two countries? I mean they must be close."

Keane shook his head slowly. "I don't know if I could do it, Jay. You're asking us to become out-and-out renegades. No company, maybe no country."

"What else can we do, man?" said Randy. "If you've got such an investment in staying attached to some company you should never have gone this far without 'em. And if we believe what we've been saying all along, we have no choice."

"It's true we have no choice," I said as quietly as I could. "Because we have no device. You're debating what to do with a theory. So let me make my suggestion on the matter: test it. Work on

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it. Maybe just maybe we've gotten this new discovery ahead of 'em. Maybe this time we can beat 'em. Maybe we can get to a point where this debate on morality will mean something. Right now it doesn't mean shit. Hey, maybe we'll be lucky and fail. Then you guys won't have to fight." Tim grinned at me.

Randy looked down and rubbed his hands between his knees. Keane took a deep breath. "Okay, point made," he said. "So we got shot down. We still all agree that what the military now has is dangerous. Certainly more so with no defense against it. So let's see if the thing's possible and decide what to do with it later." There were nods all around.

"Let's take another look at that data," the engineer suggested. Randy, Keane went into the other room and brought back the tapes from his space experiments. We shoved back a bassock and a couple of chairs and a lamp and Keane spread the papers out on the floor. Then we all got down on hands and knees or sat on our skinny asses in a circle to study them. Except for Jay. The quiet little guy always was a little less pushy than the rest of us. He waited till everyone else was settled before getting up from his chair to join us. Only it was just that much too slow.

He'd gotten halfway to his feet when he suddenly blew out his breath with a grunt and fell back, doubled over. He slipped sideways and landed shoulder first on the floor, then tumbled onto his back.

At almost the same moment we heard a series of soft thudding noises in the room, seemingly from every direction. First was one loud crack and a small wooden chair toppled over backwards.

Randy responded first. "Down! Flatten!" he yelled, grabbing Tim's shoulder and pushing him face down at the floor. I was already prone, and the nearest to Jay. I crawled to him and raised my head carefully, though the noises seemed to have stopped. Blood oozed out all over his sweater across his midsection. His breathing was irregular and labored. His eyes stared open, pupils dilated. I tried to find a pulse; no such luck. It didn't take a genius to see that it was all up for him before he ever hit the floor.

I became vaguely aware of Tim's voice, somewhere, saying, "What the hell, what's *happening?*" and Randy chanting, "Bastards, bastards, bastards . . ." Then Keane, louder: "Lou! How is he? What happened?"

I turned toward him, then looked back at Jay. He was still now. No breathing. "He's, uh—he's, he's dead," I said, and my voice felt as if I were choking on a wad of wet newspaper.

"Oh, Jesus, oh, Jesus," Randy was saying.

"*What happened!*" Tim demanded.

"Just what I said!" Randy snapped. "The bastards put a bullet through every chair in this room. They *knew!* They knew we'd be watching their fucking announcement."

"Come on," Keane said quietly. "Come on, we've got to get out of here. Come *on! Out!*"

None of us protested. We just left poor Jay there and scrambled, in a low crouch, out of that house as fast as we could. We were furious; we were grief-stricken. But we were human, and we were terrified. The thought of an attack

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from out of *time!* That the bullet that gets you was fired, perhaps days ago, by someone now in another state or country. That it could come from anywhere. You wouldn't be safe in a sealed steel box, if anyone had had previous access to that box.

Fear is a damn good instinct. We made it about halfway across the back yard before the house exploded. Most of the downstairs windows blew out with a roar and a shudder, and the whole yard turned the color of sunset. The sounds subsided and were replaced by the crackling of the flames that would obviously be taking the whole place in short order.

"Oh, Christ, what for?" I said. "Why in—why the bullets? Why both?"

"Insurance," said Keane. "And they weren't bullets. Idiot!"

"Huh?"

"I'm such a Goddamned idiot. You guys might have thought of it, but I certainly should have. Those weren't bullets, you can't fire a bullet through time and expect to hit anything. If three days seemed like a minute or whatever to you, how far ahead could you possibly fire a bullet? It's *moving*, damn it, it'd be far past its target when it reappeared. You could only send it maybe a couple of seconds. Be a fraction of a second to the bullet."

"Wait a minute, wait a minute." I tried to grasp this. My head was in too much turmoil for me to think clearly. I began to get it just as Tim said, "Then what the hell *was* that, man?"

Keane had the weirdest look on his face. Like anger and excitement and—eagerness—all at once. "They sent something at us. It couldn't have been moving. Therefore it was stationary objects."

"They've solved the gravity problem," Randy practically shouted. "They sent something to rematerialize *inside us*, for God's sake! And they kept it motionless during time travel, hanging motionless over our chairs till it reappeared. Inside Jay. Dropping into the empty chairs."

"Yeah, and that wooden chair had been moved, so it appeared inside the chair. Blew it over."

My first reaction was awe. I was thrilled. I was knocked out. The impossible was possible, it had to be, there was no other explanation. Then I was pissed because they'd gotten it first and we'd been too stupid to realize the bit about bullets. Then I felt guilty, because I realized I'd thought all these things. Not horror at the implications, not grief for Jay. We are what we are. I guess that's why Randy believed weapons were inevitable. And why he went on fighting them.

"So they have a weapon, then. A weapon that works," said Tim, calmer.

Randy nodded, his face sweaty in the glow from the burning house. "They have their weapon, and we have—Jesus, the papers!" He turned a startled face to Keane, who held up a handful of sheets and waved them in reassurance.

"Don't worry, man, I feel the same as you," he said. "I wasn't too scared to be mad. And these are all we have. All we have," he said quietly.

Randy looked at him, approvingly it seemed to me, for a long moment. "Yeah," he agreed. "All we have. "*Our* weapon."

I stared at him and I can't tell you

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what the hell I felt.

We pulled ourselves together then and got out of there by a back road. On foot. Keane never went near his car again.

There's no more I can tell you, except why I'm writing this. Everyone knows the subsequent public events: worldwide testing of time weapons, sales to allies and neutrals, the proliferation anxiety of the '40s and '50s all over again. The new spectre of phantom soldiers and worse appearing out of nowhere.

As for private events, we're still underground testing our asses off. The laughable simplicity of the anti-grav device was harder to take than being beaten to it. (Yeah, it's supposed to be secret, but Keane figured it out from what little went on public record in the scientific journals.)

We've changed some: Tim's quieter, Keane's grimmer, Randy's angrier. Our purpose is still the same: gathering data to develop this magnetic device to negate time machines. Funny thing for me to be doing. Time machines were my passion. My toys.

Anyway I hope that's still our purpose. You know one thing you could do with this thing, once it works, is to turn anything sent at you one hundred eighty degrees round, figuratively speaking, so it doesn't move in time at all. Stays right with the sender. A bomb, for example. Randy pointed that out.

Me? I don't know if I've changed. I still like my work. That's why I'm writing this. I'm no history freak, although I agree with Keane that posterity should see credit go where it's due. It's just that *I* am entitled to a piece of that credit, and I want it. I'm not likely to get it anytime soon, maybe not in my lifetime. But I have hopes. We all do. Anyway we want the record set straight on just who invented time travel.

It'll be a long time before we can go public, if ever, and of course no one will be reading this until we do. Until it's safe. We wish the rest of the world could know now what we're doing, so they'd feel, as we do, that there's still reason to hope.

As for them—Lord, we always call the enemy Them—they know we're not dead, although evidently they don't know where we are. But they must know what we're doing, even if no one else does.

We're working on it. ■

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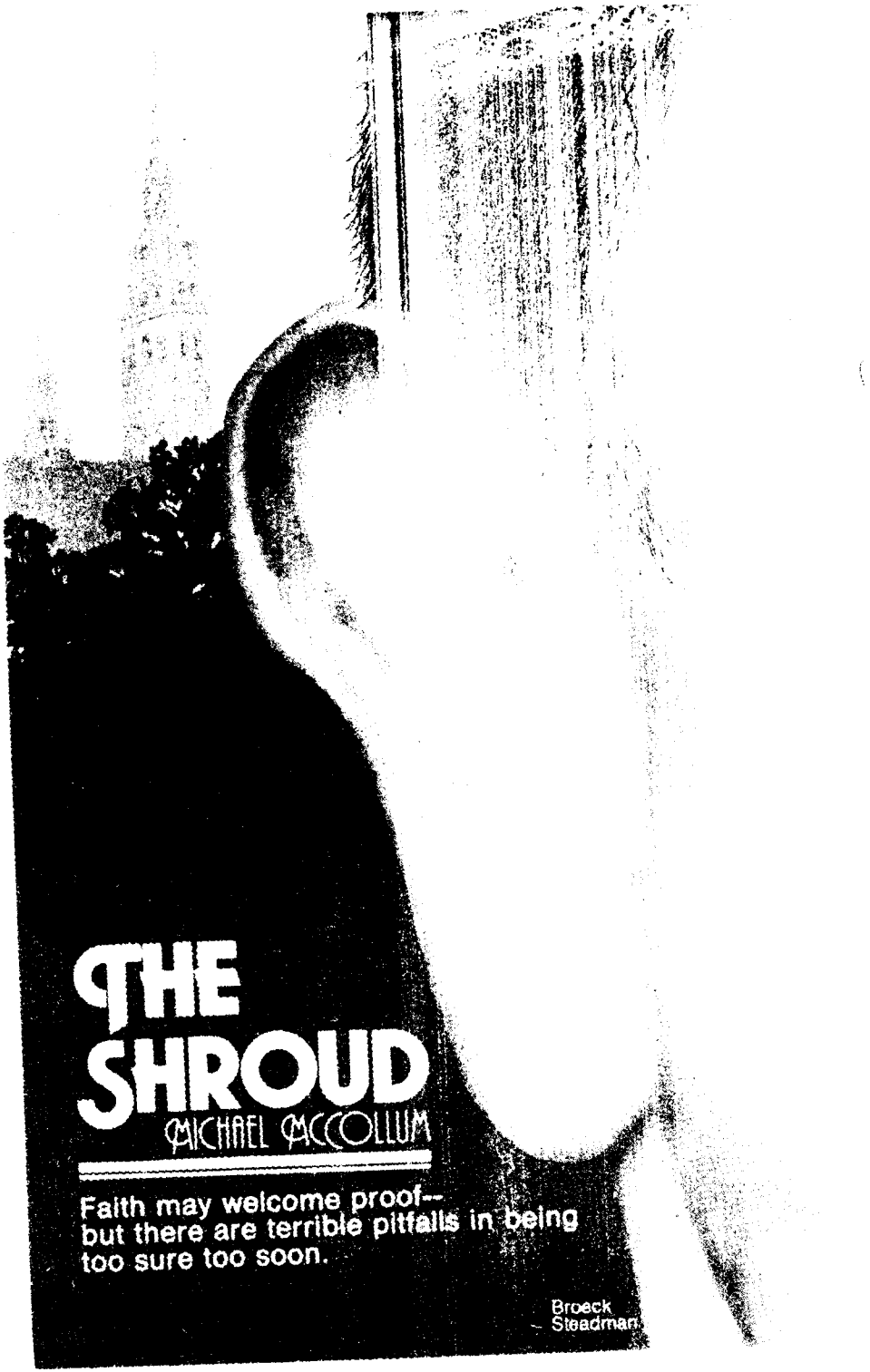

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John Frakes was jolted awake by the screech of tires on wet asphalt as the twenty-year-old airplane touched down at Aeroporto di Torino. He groaned and straightened up in his seat. The catnap on the forty-minute flight from Rome had been his first rest in thirty hours. Ever since the final lab results had been verified, his sleep had been marred by the same recurring nightmare. He would barely doze off when the stern face of his father scowled forth from his deep subconscious, tugging him forcefully back to reality.

The Reverend Lester Frakes had been a fire-breathing Episcopalian minister while he lived. Even five years after the old man's death, Frakes still occasionally woke in the middle of the night covered with nervous sweat, his hands shaking in a fit of filial guilt. His father had never really forgiven him for changing his major from Religious Studies to Chemistry during his junior year of college.

"I've raised me a damned atheist, have I?" the Reverend Frakes had screamed at him that fateful Christmas Eve when he had broken the news.

"No, sir, an agnostic."

"I will pray for you, lad," Lester Frakes had said, casting his eyes heavenward. "Perhaps the Lord will someday tear this veil of foolishness from your eyes so that you may see the path of righteousness once more."

Even then Frakes had had to smile inwardly as his father slipped easily into the old fire-and-brimstone sermon mode. As they had done so many times before, the words washed over him as though from a scalding sea, their sting intended to bend his will to that of the old man.

Only that time he had refused to bend, and in the end it had killed the Reverend Frakes as surely as a knife.

"*What would you say now, Father, if you knew what I know?*" He knew the answer even as he asked the question. Lester Frakes had always chosen a single sermon on those infrequent occasions afterward when his son had come to hear him preach.

"Never let your mind overpower your faith, my flock! Without faith we are little better than the poor guinea pigs these would-be-prophets slice open in furtherance of their evil experiments. . . ."

"You may unbuckle your seat belt, Signore."

Frakes looked up with a start. The pretty, black-haired, black-eyed stewardess who had welcomed him aboard in Rome was standing over him. He looked around, surprised to see the last of the passengers crowding towards the exit at the front of the plane.

"Sorry," he said, reaching for the buckle. "I guess I was daydreaming."

"Are you well?"

"Uh, *mi sento molto bene, grazie*. Just a little tired is all."

"You speak *Italiano* well for an American, Signore. Perhaps this is not your first visit?"

"I was here last summer for two months. I picked up a few useful phrases then."

"Well, have a nice stay this time."

Frakes levered himself out of his seat, pulling his briefcase with its precious cargo from under the seat in front of him, thankful for the chance to stretch his legs after so many hours in the air.

* * *

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Sardinian Customs was almost peaceful after the organized chaos he had encountered at Rome City State. There were none of the hundreds of soldiers and Carabinieri that the Rome city fathers seemed to think necessary. Of course, the Sardinians had no need to guard against agents of the Peoples Republic of Naples at the moment, either.

Within half an hour he was out of the airport and headed north in a cab towards the grey smudge on the horizon which was Torino.

"You are in Sardinia on business, yes?" the taxi driver asked over his shoulder as he weaved nonchalantly between an oncoming Fiat and a cryogen tanker stopped half-on half-off the road.

"Yes," Frakes said, staring blankly at the glistening wetness of the highway. The static crackle of the windshield rain repulsors and the low-throated hum of the turbine made him want to go back to sleep.

"*Ingegnere*, engineer?"

Frakes shook his head. "*Scienziato*."

"Ah, here to visit our mills for making of the plastics?"

"No, to visit the cathedral."

"You desire to see the Sacred Shroud?"

Frakes nodded.

"Signore, this is your lucky day! My brother is tourist guide. He would be most content to guide you personally. Perhaps if you wish, he will arrange a most private tour for you, Signore. The cost will be not great. No more than a million New Lire. He will speak with the Guardians and perhaps you will even be allowed to touch the Relic."

In spite of the sandpaper on the insides of his eyelids, John Frakes had to smile. "The payment will be in advance, of course; and to you, not your brother."

The driver's brown eyes looked expressively at him in the rearview mirror as his whole body underwent a huge shrug. "It is the way things are done in Sardinia these days, Signore."

"You wouldn't disappear with the money the moment I handed it over, would you?"

"Signore, you wound me!"

"What would you say if I told you the Shroud hasn't been on public display more than fifty times in the last eight hundred years?"

The taxi driver grinned, seemingly unbothered for having been caught red-handed. "I see I am in the presence of one knowledgeable about such things."

Frakes laughed. "You might say that. I've spent the better part of the last two years studying the Shroud. I know far more than I ever wanted to." Frakes felt a pang of guilt as he realized the statement held far more truth than he had intended.

"... more than I ever wanted to."

The Shroud of Turin is a piece of linen dating back to the first century, A.D. Physically, it is quite large, measuring 4.3 meters long by 1.4 meters wide. However, it is not the mere fact of the age of the material that causes the Shroud to be venerated so.

For on the surface of the Shroud, clearly visible to the naked eye, there is miraculously imprinted the image of a man. Actually there are two images, one frontal, one dorsal; each nearly

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joined to the other at the head, as though the cloth had been folded lengthwise over a corpse and then removed before the process of decay set in.

The two images are so detailed that it is possible to know a great deal about the man who once lay in the shroud. He stood 172 centimeters tall in life, was possessed of a handsome face, a beard, and long flowing locks. He lies naked in death with his legs extended to their full length beneath him. His arms are crossed left over right, obviously tied together to combat the effects of *rigor mortis*.

More intriguing than his physical appearance is the manner of his death.

On the surface of the Shroud there are a number of bloodstains arranged in a meaningful pattern. Near the hands are marks of wounds that could only have come from having spikes driven through each wrist. Similar marks show up on the feet, as though they were pinioned together with a single large nail. Clearly the original owner of the shroud was a victim of the cross.

A series of marks on the dorsal image indicate that he of the Shroud had been severely flogged by two men prior to being nailed to the cross. A large bloodstain at the abdomen shows that he was pierced through the right side by a short spear, probably as a *coup de grâce* administered after death. And most suggestive of all are the small spots of blood in the region of the head, the pattern of which suggests a Crown of Thorns worn like a cap and tied under the chin for maximum torment.

Tradition has it that the Shroud is the burial cloth of Jesus Christ, given to Simon Peter for safekeeping following the Resurrection. As to the subject of what became of the burial garment in the years that followed, the Gospels are unfortunately silent.

The first independent historical reference to Christ's burial shroud comes from Saint Nino in the third century. Then, in the year 570, an anonymous pilgrim from Piancenza reported that it was being kept in a convent in a cave by the River Jordan. And again, during the seventh century, a French bishop named Arculf told a tale of having seen the Shroud in Jerusalem.

For six hundred years there were no further reliable reports of the sacred cloth until 1204, when Robert de Clari, a chronicler of the Fourth Crusade, reported its presence in Constantinople. After the Crusaders plundered that great city, however, "no one, neither Greek or Frenchman, ever knew what became of it."

The Shroud surfaced again in 1356 in Lirey, France. Then on December 4, 1532, the Shroud was involved in a fire in the sacristy of the Sainte Chapelle of Chambery. Its silver casket overheated and drops of molten metal fell on the folded linen, burning a series of deep black scars into its surface, luckily leaving most of the image unharmed.

In 1578 it was moved from Chambery to Turin on orders of the duke of Savoy. And in Turin it rested for the next five hundred years.

For most of its history after 1356, the Shroud was believed to be a fake, a clever painting done by some unknown Michelangelo for the greater glory of God. Only in the nineteenth—and later the twentieth—century, with the invention of ever better photographic meth-

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[illegible] the true nature of the Shroud [illegible]. Quite simply, the Shroud was exactly what it appeared to be: the burial [illegible] of a first century martyr. [illegible] forensic study of the image's [illegible] of detail showed that no medieval artist, no matter how great a genius, could possibly have been so precise.

As increasingly powerful scientific tools were brought to bear on the Shroud's authenticity, the question of whether or not it was truly Christ's image on the linen became ever more important. As in the case of most questions of religion, opinions were varied [illegible] and heated.

The Cathedral of Saint John the Baptist showed few indications that it had witnessed nearly a thousand years of turbulent history. Its great double doors stood agape, as if welcoming one and all to enter and take refuge within the dim, cool interior. Here and there across the cathedral's stately face were the pockmarks of machine gun fire, some dating back to the Second World War. Other, smaller caliber pockmarks were less than thirty years old, stark evidence of the breakup that accompanied the Second Reformation.

John Frakes wearily climbed the eight steps to the cathedral's entrance and crossed the threshold into the stone hall, not glad to be out of the [illegible] that fell from a grey sky. As a [illegible] was acutely conscious of the [illegible] glow that washed over him [illegible] and out. The outer warmth came from the cathedral's efficient central heating system, installed by the Franciscans when they carved the Shroud's resting place from solid rock beneath the foundation during the Time of Troubles. The inner warmth came from the knowledge that untold generations of men had trod this floor before him. Agnostic or not, Frakes couldn't help feeling a certain reverence whenever he thought of the lives so intimately entwined with this building and its sacred treasure.

There had been Secondo Pia, the first man to photograph the Shroud. It had been he in 1898 who had first clearly seen The Face in the Shroud as it appeared so starkly in one of his old fashioned glass negatives. Later the photographer had described that instant as an intensely personal religious experience.

Then there had been Filippo Lambert and Guglielmo Pussod, who risked their lives rescuing the Shroud's silver casket from the flames at Chambery. And later, Princess Clotilde of Italy, who knelt on rough stone floors and, stitch by stitch, attached the backing cloth which protects the Shroud, refusing all help until the job was finished.

Frakes was suddenly conscious of standing inside the cathedral with chills running up his spine. He flinched visibly as he remembered where he was and what he must do in the next few minutes.

His reverie was further interrupted by the hollow clatter of leather soles on the stone floor. A man dressed in a business tunic and neck collar came into view from between two of the giant pillars and made straight for him. Frakes shivered a little and waited for the other to reach him.

"Doctor Frakes?" the reverend asked as he reached the waiting scientist and

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extended his hand.

"Yes," Frakes said, taking the hand. The other's grip was firm, but not bone-crushing.

"The First Primate regrets he will be delayed a few minutes. I am his assistant, Giuseppe Calle. He has asked me to entertain you until he can arrive."

"You speak English very well, Signore Calle. No trace of an accent at all."

Calle smiled. "Don't let my name fool you, Doctor. I'm from Cleveland."

"What happened to Bartol?"

The Guardian lifted his hands. "He is on a religious retreat in the mountains."

"Sorry to have missed him. He was indispensable to me last summer."

"Ah, yes. The Great Enquiry. I've been meaning to ask you. What were all those immense tanks the news people kept taking photographs of?"

"Helium. Your Primate refused to break the seal on the Shroud's casket until we had flooded the whole underground vault with helium. I worked for nearly a week in breathing gear. You may have seen me in the newsfaxes. I was the one who looked like a drunken spaceman home on leave."

"Ah yes, I remember," Calle said, nodding. "Have you been shown around our great cathedral?"

"I was given a very extensive tour while I was here earlier this year."

"Then you are familiar with our Order's history and works?"

"Only what I read in the fax, I'm afraid. My work, you know . . ."

"Yes, we all have our work. You explore the natural universe while I do the same for the spiritual. Perhaps we two are more alike than you know. May I give you the nickel tour while we wait?"

"By all means."

"A bit of background first, then. You know, of course, that our Order is not associated with any formally established religion. We make no claims of new insights into the nature of God, or of a private channel direct to His ears. We were founded in 2009 by a man named Bartolo Vasquez, a simple layman whose sole purpose was to protect the Holy Shroud from the exploitation so common in those days. We are an ecumenical organization. We care not if one of our members is Methodist, or Catholic, or Anglican, or Coptic. We ask only that he be a good Christian and to believe in the Shroud as the burial cloth of the Saviour.

"Beyond that, we ask him to go forth and do good works."

Frakes nodded. "I'm familiar with your medical center in Denver. A really marvelous place."

"And then there are our missions to feed the poor and starving of the world," Calle continued. "Last year we spent over ten billion decadollars on our public charities. But then what is money for if we can't help others with it?"

"Your Order has grown mightily in the last couple of decades," Frakes agreed.

"Do you know why?" Calle asked.

"Because of the Shroud."

"Yes, of course. Unlike the various established Christian religions, our Order has absolute physical proof that our Saviour died for our sins. The others have their faith, a faith which we share,

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I might add. But we have absolute proof! Is it any wonder that we attract so many supplicants each year?"

"Only the good doctor doesn't think our proof is genuine, Calle. Do you, Doctor?" The new voice echoed through the sitting room to which Calle had directed Frakes as they talked. Frakes turned to face the source of the sound.

Standing behind them was the First Primate of the Guardians of the Shroud of Turin—next to the Pope, the most powerful man in all of Christendom.

The First Primate was a tall, wizened man whose strongly lined face still managed to convey the feeling of complete inner peace. At the moment his features were contorted by a wry grin.

"Absolutely no proof that the Shroud is that of Jesus Christ.' Wasn't that what you told me at our first meeting, Doctor Frakes?"

"I fear I am being quoted out of context, Primate. What I said was that absolute proof is not possible. We know that the Shroud is a burial cloth, but it was my opinion last summer that the identity of the man in the image could never be proven with utter certainty."

"Does your curious phrasing of that answer mean that you have changed your mind and absolute proof is now possible?" Calle asked, excitement creeping into his voice.

"No, I—"

The Primate held up his hand. "Just a moment, Doctor. Perhaps we should get one thing clear. Do you know why I granted your request last year and allowed you to scan the Shroud with your marvelous machine?"

"Frankly, Excellency, I truly don't. I was both surprised and pleased when I received your letter."

The First Primate nodded. "I understand you were turned down by quite a number of others."

"Yes, Excellency. You must understand that I am not a religious man. My father was a man of the cloth and hoped I would follow in his footsteps. I'm afraid that it wasn't to be. Instead, I have spent my professional career working on the genetic structure of human blood and how it has or has not changed with the centuries.

"The basic problem in my field, of course, is getting samples of ancient human blood to perform tests on."

"Which brought you to us," the Primate said.

"Yes. The two places where I could obtain material for my experiments were the mummies of Egyptian pharaohs and, of course, the blood stains on the Shroud. The tests are nondestructive, so I hoped there would be no objections to the procedure."

"And the Egyptians turned you down while I accepted," the First Primate said.

"Yes, Excellency."

"But why are you so surprised?"

"I told you, Excellency, I am not a believer."

"In this case, Doctor, that factor worked in your favor."

"I don't understand."

"Do you know what the Achilles' Heel of Christianity was before the Shroud was authenticated, Doctor?"

Frakes shook his head.

"The lack of validation by nonbelievers, of course. Are you aware that there are no eyewitness accounts of Christ except for those in the Bible?"

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Frakes opened his mouth to object, but the First Primate stopped him with an impatient gesture. "No, it's true. Oh, no one doubts that He existed. There are historical references to His existence from the first century, commentaries written by men who lived shortly after His time and who do not contest the fact of His existence.

"But think, Doctor. How much better it would have been if we had even a single scrap of evidence that was not basically Christian in origin. Would it not be nice to have a pagan's account of the Sermon on the Mount? Or perhaps a Roman soldier's letter home telling of the crucifixion of another Hebrew troublemaker? Some corroborating evidence, as it were, from a source other than our own holiest of books?"

"I guess I never looked at it that way, Excellency."

"For two thousand years the world's Christians took their religion on faith alone. Now faith is a wonderful thing, but is it not so much better to have proof? That, at least, is the cornerstone on which our Order was built. It is, I'm afraid, the main source of friction between ourselves and the old established religions. Many of them still believe faith is enough.

"Whatever your side in that argument, however, it still remains that a number of sophisticated tests on the Shroud—the extensive analyses of the 1980s and 1990s—could not prove it a fraud. To those of us in the Order, they went much farther than the negative finding that shows up in the final reports. We have pondered the evidence and find it sufficient to prove our case beyond any reasonable doubt. It is on those results that our beloved Bartolo built this Order."

John Frakes licked dry lips and wondered why it was suddenly so cold in the sitting room. He chose his next words carefully, wishing that the buzzing in his ears would subside long enough for him to concentrate on the business at hand.

"I do not wish to disagree with someone as learned as yourself, Excellency, but all those original tests proved was that the Shroud is truly the burial cloth of a man who was crucified. There was no proof whatever that he was the Son of God."

The First Primate smiled. "Which brings us to why you are here, Doctor. We are an Order that has no fear of science. As I have explained, our founding was the direct result of those earlier test results. But those discoveries were somewhat limited in scope, as you have pointed out. The earliest researchers into the Shroud used nothing but their naked eyes. Later cameras and microscopes and Carbon-14 dating techniques were used in conjunction with computer analysis. These studies yielded many valuable results, but were still limited by the fact that—except for a few small samples taken during 1973—all tests have had to be nondestructive in nature. Those early Keepers of the Shroud were quite correct in refusing to allow additional pieces of the sacred cloth to be removed. If every scientist who wanted samples had been accommodated, there would be little more than a handkerchief-sized piece left today."

"So you granted my request to examine the Shroud because my investi-

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gations are completely harmless?" Drakes asked.

"That reason among others," the Primate said. "Even so, I had a hard night of it before making the decision to grant your request. If you had been one of us, if you truly believed that the Shroud was our Saviour's burial garment, I would probably have turned you down."

"I still don't understand, Excellency."

"It is quite simple, Doctor Drakes. I am asking you, pagan at the Sermon on the Mount, my Roman soldier who was present at the Crucifixion: You have no connection with this Order and a worldwide reputation for honesty and scholarship. I have chosen you solely on the basis of your lack of interest in the Shroud as a religious relic. To you it is merely a means of gathering data in your own specialty. To put it bluntly, you have no axe to grind and no reason to lie."

"So you will go forth and publish your results. And as you have used our Holy Relic for your purposes, I will use your findings for my own. You scientists believe that serendipity plays a great role in your work, do you not? We of the Order are more inclined to believe in something a bit more personal than the blind workings of the laws of chance. I feel it was the Hand of the Almighty which steered you to us, and I will use your discoveries for the further Glory of Him who sent you. Now, I am pardon my excitement but I have waited most of my adult life for this moment. What can you tell us of our Savior's Body?"

Drakes cleared his throat and averted his eyes, keenly aware that the moment of truth was upon him. His stomach gave a warning twinge, a sure sign that his ulcer was returning, as he ruthlessly suppressed the memory of that tough old preacher whose heart he had broken so many years before. "*Will you ever forgive me, Father? After all, it was you who drilled honesty into me. Maybe if you hadn't swung that belt so hard, I could look this good man in the face and lie now.*"

"Come now, Doctor. Out with it. What have you discovered?"

"As we discussed, Excellency, I first concentrated my instruments on the body images rather than the blood stains. It has been a mystery for centuries just how the image came to be on the cloth of the Shroud. Well, the mystery is mysterious no longer. The image is the result of a complex, but perfectly understandable, chemical reaction. I have a report in my briefcase that you can study at your leisure."

"Go on."

"Our next objective was to determine the chromosome structure of the individual whose blood is on the Shroud. This is what took the better part of four months. You understand, Excellency, that there is much we do not know concerning chromosome structure. We have another millennium of study before us to begin to understand the underlying principles. But in our initial, groping way, we have learned to recognize some of the baser aspects of the pattern.

"We scanned the cloth and developed sufficient data to recreate the structure of the dead man's chromosomes with a ninety-five percent probability. We then analyzed the pattern

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extensively. The man whose shroud that is in your underground vault was almost surely a Semite. With one exception the chromosome pattern correlates well with that of a modern man of Semitic extraction."

"Exception?" the First Primate asked, his manner suddenly intense. "You have found evidence that this was no mortal man?"

"Not exactly, Excellency."

"Out with it, man! Was it Our Lord or not?"

"No, Excellency, it couldn't possibly have been. The very idea is grotesque, unthinkable."

"You let me worry about what can be thought or not thought, Doctor. What have you discovered?"

"The chromosome pattern, Excellency. It had a deformity in some of the peptide chains. It took us quite a while to identify it and even longer to check our conclusions. In fact, the implications are so far-reaching for your Order, that I had the work completely rerun six separate times. There can be no mistake.

"The man who lay in the Shroud had a genetic defect. He suffered from a condition known as Kurusoku Syndrome."

"We are not medical people, Doctor Frakes," the First Primate said, an edge developing in his voice. "What does that mean in English?"

"Kurusoku Syndrome was first identified around the turn of the last century. It is a genetic disease characterized by a progressive reduction of the afflicted person's mental capacity, an ever-increasing sense of disorientation with respect to reality, and if allowed to go untreated, can lead to delusions of grandeur. If it were proved that the Shroud were the true burial cloth of Jesus Christ . . .

". . . well, I think you'll agree that the consequences for Christianity would be catastrophic."

It was twenty minutes after the alarm went out that the first ambulance arrived on the scene. For the better part of an hour the doctors worked on the First Primate before they dared send him to the coronary unit of Our Lady of Fatima Hospital on the outskirts of Turin. He was given only a fifty-fifty chance of surviving the night. As John Frakes descended the Cathedral steps to the waiting cab, he shivered in the cold drizzle. He sat inside the vehicle in a daze. All he could remember was the memory of the old man's eyes just before the heart attack took him. The look of betrayal was one that would stay with him all the rest of his life.

It was the same look that had been frozen on his father's face on that fateful Christmas Eve so many years before. It was the look that now haunted his very dreams.

Somehow he knew that it would haunt his dreams for a long time to come. ■

● Science has not accounted for morality, truth, beauty, individual responsibility or self-awareness; and many people hold that, from its nature, it can never do so.

DAVID LACK

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ALTERNATE VIEW

NUNC DIMITTIS

JERRY POURNELLE

We—this generation, we the people of the United States—could within ten years make as fundamental a change in human destiny as was ever made. We could participate in the next stage of humanity.

Alvin Toffler's newest best-seller *The Third Wave* divides human history into three periods. Marx (whose general ideas Toffler follows) had four (or five) stages. Other historians employ slightly different schema, but all seem agreed that there have been only a very few critical stages in the history of our race. All seem agreed that certain key inventions divide one stage from another. The domestication of animals; harnessing of [illegible] invention of agriculture, invention of the wheel, the Industrial Revolution, these all seem as crucial watersheds. Why? Some things were different.

[illegible] together with Mohammed Mahmood Alamagordo Bikini [illegible] the same. If so, then we [illegible] privileged [illegible] we are [illegible] crucial [illegible] of the [illegible] indeed, unless the new [illegible] invented by Fermi at Jackass Flats [illegible] obsoleted and negated, we may [illegible] the *last* watershed event of human development; but fortunately we have the means at hand. We can go beyond the nuclear era. Indeed, we can, if we want to, usher in new developments so profound that we have to go back to the invention of language, or the evolution of lungs to find anything as important.

I was recently privileged to participate in a study of the future. Sponsored by Dr. Robert Frosch, Administrator of NASA (who was an active participant in the week-long activity), the study was instructed to examine possible advances in artificial intelligence and remotely operated equipment and develop "bold new missions" for the next fifty years. For a week we—about twenty of us, including John R. Pierce (Chief Technologist at Jet Propulsion Laboratories, and better known here as JJ Coupling), Roy Smelt (former Chief Scientist at Lockheed), Marvin Minsky (Artificial Intelligence Laboratories, MIT), several NASA project directors, and others of that stature—looked at just what we can do right now in space.

The idea was this: can we put into space an automated system which can use space materials to build copies of

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itself? (One of our conclusions was that anything that can replicate itself will necessarily be so complex that it *must* be able to make useful byproducts. As a worst case you can harvest factories.)

The results were interesting. First: we cannot yet put up self-replicating unmanned systems. You can make some fairly complex machines—the Japanese are even now building 90 percent-automated factories to produce automobiles—but you can't "close the loop." It's not impossible to get *nearly* everyone out of the system, but getting the *last* human out takes orders of magnitude more effort than getting out the next to the last one.

Second: we can build a lunar colony. Now. This decade.

Note what we said. Colony. (Or, as one NASA official suggested, "settlement"; "colony" is not an in word this decade.)

Colonists do not expect to return. Colonists expect to live out their lives in their new homes. It's not at all clear that we can put up a lunar *base* in this decade; but the probability that we can build a VERY nearly self-sustaining *colony* approaches certainty. Now true: the colony will not, for another twenty or more years, be truly self-sustaining. It will doubtless need help. Vitamin pills. Tools. Certain chemicals (of which more later). And above all, communications, including *skills*.

But—whoa! Pournelle, haven't you just lost your mind? How can you import skills without importing people? I mean, sure, we see that communications can help a lot, but some jobs just take a long time to learn. An experimental mechanic, or a screw machine operator, can *tell* you what he does for months, but *you* won't be able to do it. Not as he does.

Agreed; and yet we can import skills.

The secret is Waldoes.

Long time readers of science fiction will remember the novella *Waldo* (sometimes published as "Genius in Orbit") by Robert A. Heinlein. It introduces the concept of machines which amplify human effort: that is, one puts one's hands into the control gloves, and whatever one does there will be repeated by a pair of mechanical hands at a remote distance. The remote hands may have super-human strength and hyper-human dexterity. They may be much better than human hands (at least in theory). Thus, Waldoes can *amplify* what people do.

Now the problem with lunar colonies is people. It's not so hard to support machines on the Moon, but human beings require fairly benign environments. Oh, sure, we're tough and far more self-repairing than machines; but we do need a relatively narrow range of temperatures, pressures, and chemical exposures. We need a complex support system too: either ways to grow food (living stuff which itself needs a controlled environment) or continuous supplies of foodstuffs from outside; plus oxygen and water and all that.

Machines, on the other hand, will tolerate conditions that render people inoperative. They don't take *nearly* as much support paraphernalia as do people. Except for one problem: the machines, ultimately, need human attendants. They aren't self-repairing. They don't understand themselves.

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[illegible] that the AI [illegible] people are working on the [illegible] be long, they say, [illegible] machines that know [illegible] understand [illegible] what [illegible] thus enabling [illegible] to [illegible]

Real Soon Now

[illegible] cynical, it's because [illegible] few years ago John McCarthy, of the Stanford Artificial Intelligence Laboratories, bought a Heathkit [illegible] the idea that we'd have [illegible]—and no AI outfit [illegible] that can open the packing [illegible] that this is not intended [illegible] John McCarthy who's [illegible] found but [illegible] the most [illegible] people I know. Nor do I [illegible] that actually the AI people will [illegible] robots capable of constructing a Heathkit color TV and also [illegible] spark plugs in my car, [illegible] doing an Orange 13, [illegible] diapers and dig[illegible]

[illegible] do it yet and they won't [illegible] a number of years; [illegible] way. Maybe more.

[illegible] build Waldoes in the [illegible]

[illegible] will let us explore the Moon.

[illegible] situation. A colony of twelve to twenty people, [illegible] probably married couples, goes to Luna.

They may not have lifeboats. If they're true colonists, they'll have insisted that the payload mass that might have gone to lifeboats be put into additional supplies and equipment to insure the survival of the colony.

One of their tasks is to construct a means to inject lunar material into orbit and start sending up mass which can be used for orbital construction. It won't take many hundreds of tonnes of lunar materials—including oxygen, which is plentiful on the Moon—put into Earth orbit before the lunar colony has made a profit.

Their primary task, though, is to survive; to build the lunar colony and make it permanent. This is likely to take up most of their time for several years. There isn't going to be a lot left over for mining and refining and constructing a mass-launcher. They'll be too busy carving out living quarters and assuring their oxygen supply. There'll be no one to drive the bulldozer—and this means there won't be profits, which probably means no one will pay for the colony in the first place.

Enter Dr. Marvin Minsky, of MIT's Artificial Intelligence Laboratories. Minsky points out that Waldoes can effectively multiply the number of lunar colonists, thus making it possible for the colony to begin work on the payoff system. With Waldoes we can have three shifts a day working on mines and refineries—and also have considerable variety in the skills effectively on the Moon.

Note that this also impacts on the colonist selection criteria. Since we don't have to import all skills—indeed, if the Waldoes are constructed well enough there are very few skills which must be physically present on the Moon—we can select for ingenuity, health, motivation, hardiness; we can look for highly motivated generalists,

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leaving the specialists down here.

During the NASA conference Minsky and I also worked out that DuPont Kevlar is strong enough to make a centrifugal sling that can throw material off the lunar surface. It won't be necessary to make enormous linear mass drivers to get lunar mass into useful orbits. Thus, if we have the colony, we have a good chance at profits.

Now, back in the Sixties I was part of a team that designed a small semi-permanent lunar base. We did enough engineering to conclude it was feasible. Now we know a lot more about the Moon, and although there are some tricky design features, I don't see any show-stoppers. The lunar colony can be constructed with today's technology. Thus two elements of the colony require only engineering development, not new technology.

Unfortunately that's not true of the Waldoes. Not only don't we have good Waldoes, we don't even have a good five-fingered mechanical hand. Despite enormous advances in computers, despite development of smarter and smarter programs, we're not much closer to Waldoes now than we were twenty years ago. But cheer up: the main reason we don't have good hands and working Waldoes is that no one has ever been willing to pay for them.

Which, as Minsky points out, is plain silly. Example: how much would it have been worth to have a good Waldo inside the containment at Three Mile Island during the crisis period? (For that matter, what would it be worth *now?*)

Given the costs of operating the deep submersible *Alvin*, why must research-

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[illegible] clumsy two fingered [illegible] collecting specimens [illegible] them? What would [illegible] way to have full [illegible] at the bottom of the [illegible] inside the well shaft?

We have Waldoes here on Earth, and [illegible] not to be doing the research that would produce them. Ah, well, the Japanese will build them if we don't.

Now [illegible] operating Waldoes on the Moon is a bit more complicated than running them here on Earth, because of the 1.5 second each way communications lag. When you tell the bulldozer to do something it doesn't get the order until more than a second later; and the acknowledgement doesn't arrive until nearly 3 seconds have elapsed. Note, however, that this doesn't prevent highly complicated operations; it only means that the most delicate things must be done slowly.

In fact, though, by installing computers in our Waldoes, we can do even better. The computer need not know in advance how to do anything at all; but it can follow what the human Waldo operator has done, remember that, and in future do that for itself.

Note what that does: not only can most of the lunar work be done by teleoperators working three shifts on Earth, but as time goes on even *that* work becomes increasingly automated as the smart on-board lunar computers learn how to do it.

Costs fall as production rises. Meanwhile, the colony expands (it takes about 15 years for humans to replicate themselves). New professions arise: prospectors, engineers, gadgeteers, systems analysts who *understand* the Moon. And all of this with minimal investments from Earth.

You can see where it leads: highly automated, highly productive space systems; an economics of abundance, where a major problem is to persuade enough people to accept gifts. That stage takes a while to reach, but once we go to space in a big way—it's inevitable.

Given Waldoes, we will have the moon; and once we have lunar colonies, we're on our way. The planets, the comets, and eventually the stars will be ours—and we will have seen it begin. Some of us can even be a part of it.

What more can we ask for? ■

● The spread of science has made us feel that we ought to be "broad-minded" and try to understand every point of view. But that does not mean that we have to accept them all.

It is still more important for us to maintain the right of our own natural tastes at whatever cost in "narrow-mindedness". Every man of good sense knows when not to argue and has his mind made up on a thousand subjects that are not discussible for him. In fact, without a closed mind one cannot have an open mind. One becomes a house that has no walls, and I should not call that an open house.

VAN WYCK BROOKS

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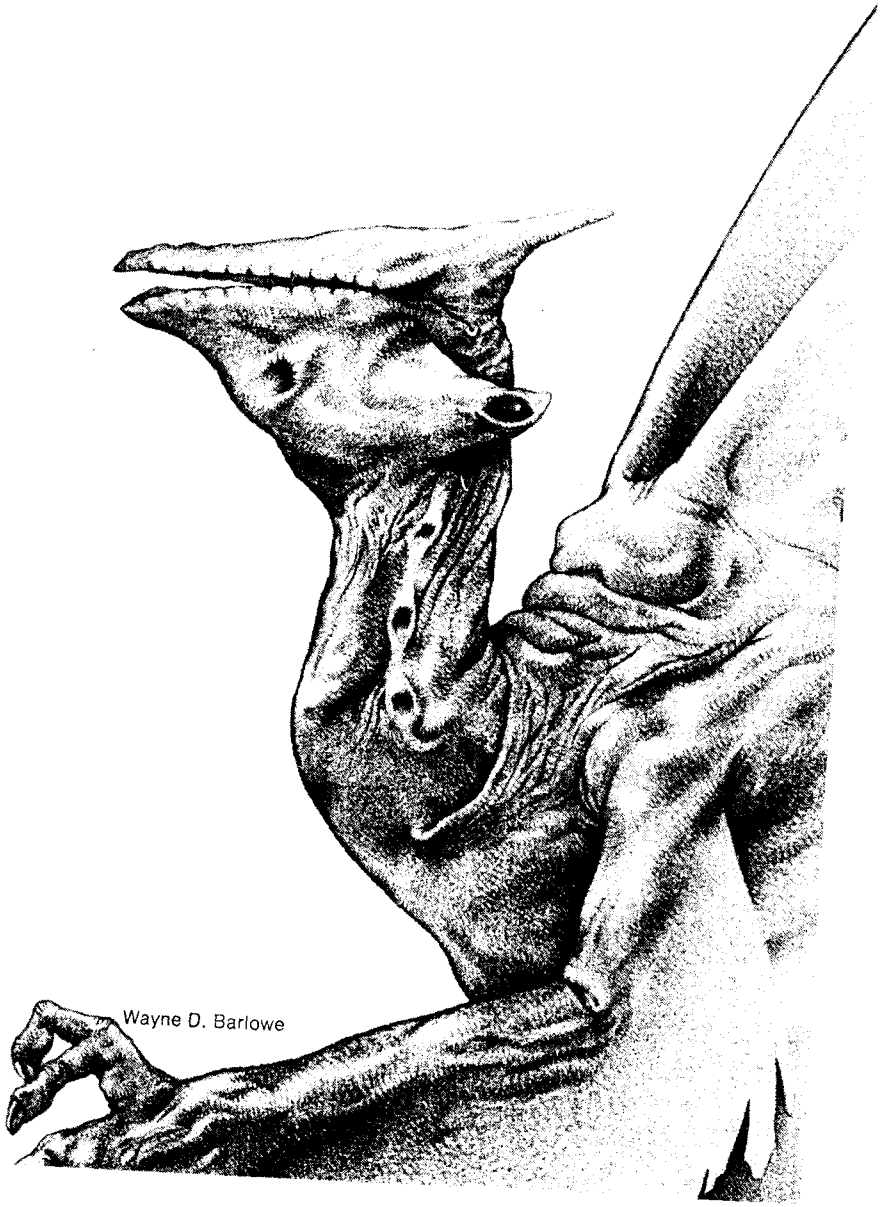

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MUSTARD SEED

BY GAYGE CARR

(With apologies to Ogden Nash)

In the centuries to come, a lot will change
in the ways people live—
but some things won't.

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"That rotten dragon's in the hybrice again!" Ulysses, Euphony/2, lunged up the plank steps from the underground home, grabbing the porchbroom as he went. "SHOO! Shoooooooo! Out, out—not that way, you idiot animal! You're trampling the—Gina, if you don't stop laughing and come help me—*SHOOO*!"

His furious shouts brought the other adult members of the Euphony sextet, and among them they managed to herd the huge but placid animal away from the crops.

The hardest part of the herding was that Mustard tended to lick—affectionately, not hungrily—at whomever was closest; and being licked by a yard-wide tongue, however lovingly, is the equivalent of being wrapped in a sopping towel.

The weed bin was empty.

Mustard gave one probing lick with his flexible lemon-creme-colored tongue and bleated disconsolately.

"No wonder, poor Mustard," exclaimed Copper, youngest and last married (and thus Euphony/6) of the sextet. "Poor baby, somebody forgot to feed him. Whose turn was it?"

"I don't care whose turn it was," Ulysses blustered, remembering suddenly *who* had forgotten, hoping the others wouldn't remember too. "He knows he's not supposed to go into the fields. We've little enough time left before Swarming anyhow, and—"

Mustard bleated again. "I'm *hungry!*" that complaint meant, and they all knew it. Not that his vocabulary was particularly large. It consisted of: "I'm *hungry!*", "I'm *very* hungry!" (about two octaves above middle C), and "I'm *extremely* hungry!" (practically inaudible, except that it made all the humans' teeth ache for hours).

"If I've said it once, I've said it a hundred times." Ulysses *hated* being interrupted. "That animal eats more than he's worth!" Gina, Peach Blossum, and Menachim chorused with him, laughing, while Copper and Jomo hurried into a barn to haul out a bale of the dried fibrous plant they called "hay."

The argument pro/con Mustard went on while that animal munched contentedly on his hay. His great wings, which looked more like fish's fins than wings, thanks to rows of heavy, flexible spines that supported them, were spread wide to absorb as much as possible of the heat from the just-over-the-horizon sun. Later, as it got warmer, the wings would rise to the vertical and then fold, lying like a mustard-colored opera cape along the curving back. If the heat still rose, the process would reverse, the wings rising and folding so that the special reflector stripes on their upper surface made a continuous shield, a dragon-size sunshade.

The argument ended abruptly when Ulysses turned to Menachim to make a comment and set his bootsole on one of the amber spheres called Dragon's eggs. They were hard and round, made of organics the sextet hadn't gotten around to analyzing yet, smooth enough so that they had a very low coefficient of friction. Ulysses did an involuntary split.

"Mustard!"

Even the slowest-witted dragon could recognize that tone, and Mustard hurriedly waddled away, but not before his tail had added insult to injury by knock-

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ng Ulysses back down just as he had scrambled to his knees.

The rest of the sextet were laughing too hard to help him up.

"It's going to be one of those days," Peach Blossum muttered to Jomo.

"Like the time the kids managed to pry addresses for all the farm equipment control programs out of Central, and reassigned every program."

Both of them grinned, remembering the tractor trying to climb the fence to chase away marauding gaws, while the scaregaw trundled down the crops, mushing them instead of harrowing.

"Gina." The terminal on the barn door spoke.

"Gina here. What's the matter?"

"The children have refused to answer my questions, and are sitting on the floor playing marbles with the Dragon's eggs again."

"Oh, they are, are they?" Gina stalked toward the house. "If they've got too much energy to sit still for lessons, they can by the Mother come out and help cross-pollinate the north forty."

"One of those days," Peach Blossum repeated.

The pirate was a deliberately handsome man—sculptured ebony hair and sculptured bronze muscles, the latter displayed in a costume that consisted of a crimson loincloth and matching thigh-high crimson boots.

Not that he announced himself as a pirate, of course: there is a time and a place for flaunting, and a time and a place for dissembling, and he had survived this long in his risky trade by knowing well which was which. So he commed a most innocent message from his spacer, a half standard hour before his ETA. Central received the message and buzzed Menachim, who was final arbiter for the day. When Menny wasn't close enough to a terminal to answer within a reasonable period, Central buzzed Peach Blossum, who was. (Not that it probably mattered, in the long run: geniality was part of the pirate's stock-in-trade.)

Peach Blossum had never thought of herself as particularly susceptible, but the pirate was *very* charming, and she found herself inviting him to land and share a meal while his life-systems were re-generating. After all (she told herself) his destination (he said) was halfway around the planet, and to go there physically, as he intended, would take time and supplies; but for the colonists, the console communicator made distances somewhat meaningless. The Periph octet, half a world away, were good friends of the Euphonys. And any friend of the Periphs . . .

He wasn't a friend of the Periphs, he was a pirate; but he had done his homework well.

They lowered their defenses.

Mustard ran and hid in the barn, cowering and whimpering, as soon as the approaching spacer became barely audible. But since he did that for almost anything in the air that made a sound or a shadow—or anything strange on the ground, either—nobody was warned.

The older children were fascinated by the pirate. Though Central's communicator console could show them holo relays of their friends scattered across the planet, actual face-to-face meetings were rare.

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"Can you really see out of the eyes on the back of your head?" asked Dierdre (Deede), her own liquid-green eyes impossibly wide.

"Of course, little lady." The pirate oozed charm. "What's the use of paying for something you can't use?"

Ulysses humphed. What was good enough for Great-granpap First-lander was good enough for him. If Great-granpap thought recombinant gene programming was enough for his descendents, *he* wasn't going to meddle with *his* already formed DNA, much less his physical body.

"Hai, Captain Wys—wyszynski." Ulysses Junior (Juney) actually had more of Jomo's genes than Ulysses's, since the computer said that was the optimum combination; but local (planetary) custom named the oldest "son" after the oldest adult male. (Ditto the oldest "daughter" and oldest adult female; but Gianetta hadn't worked out and had been traded early.)

"Call me Tuffy, son, call me Tuffy." He grinned at the adults. "Short for Tartuffe, which is what my folks saddled me with." He bowed, sharing it somehow, among the three adult women and Deede. "Tartuffe Wyszynski, Captain-entrepreneur, at your service." (It was his latest alias, computer-analyzed for the soothing innocuousness of "Tuffy"; he enjoyed the Tuffy/Toughy irony, and the slight thrill of the danger of one of these hicks ever realizing that Tartuffe was an old slang expression for "Deceiver." And who'd expect a jawbreaker like "Wyszynski" to be anything but real.)

"Gee, Captain Tuffy," the boy grinned, showing mismatched teeth, (even RGP couldn't solve every problem) "what big ears you have."

The pirate wriggled his ears, easily visible because his hair had been removed below the continuation of his forehead line, a priest's tonsure in reverse. "The better to hear you with."

"Gee, Captain Tuffy," Deede joined the game, "what . . ." she searched, "big feet you have."

"The better to walk in swamps with," he told her, grinning. "I have mudshoe feet-adaptations. If I took my boots off, you could see them." He spread his fingers wide. "Good for mud, and snow, too. I need a special program for my boots, but it's worth it if you have to work on as many odd planets as I do."

"What big hands you have." Little David joined the game.

"The better to grab you with," and the pirate swooped and tossed the screaming-with-laughter boy high up into the air, catching him only to sail him up again and again.

Johntrude, the youngest of the children, continued to suck his/her thumb and watch, wide-eyed.

Menachim nudged Copper. "I said that kid was a mistake. Let's trade him/her off before he/she becomes too deeply attached. And forget "progress"; let's keep with one-sexers."

"Menny," she whispered back, "we can't. He/she's been here too long already. Besides—"

"Longer we wait, worse it'll be."

"Besides, there's nobody to trade him/her *for*."

"So let somebody owe us one offspring, I don't care. I don't like the idea of my family marrying—I want that kid

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[illegible] don't bring it up for a family [illegible]."

Men[illegible] that's old prejudice."

"Old prejudice my foot. The kid [illegible] grinches. Look at him/her now, cowering in the corner with his her thumb in his her mouth like a three [illegible] while the rest of the kids [illegible]

Now, Menny, you know the baby's always been sensitive, and some people well, don't understand . . ."

Peach Blossom flocked to the child, trying to make him herself as small and inconspicuous as possible, and away again. Because her own attention was divided between the pirate, the child, the newcomer, and the others in the room, he didn't realize how often the wide, black-haired eyes filled with fright moved from the pirate to fix on him.

"Sensitive," he snorted. "Teep, you mean. He/she's developing teep."

Menny, are you sure?"

If I were sure, that'd be it, E.T. it. But we think so. And I'll not have that kid—baby, my foot!—scrambling around in my mind." He and the other adepts might routinely Link, or share [illegible] Pass Psyches, or any of several forms of mechanical/electronic [illegible] with the other adults [illegible] an uninvited child-ob[illegible] he gene manipulating technicians produced duals, or completes as they were sometimes called, were [illegible] and tricky. Their creations [illegible] superior in mind and body, [illegible] But in any new tech[illegible] there were sometimes mistakes, [illegible] side effects; and not all [illegible] appreciated.

[illegible] with us." But the specs said that if there were mental serendipities at all, they'd most likely be with animals, with their simpler minds. And you know we agreed that anempathy or animal teep would be useful—"

"Well, maybe I know better now. I've got *news* for you, girl. *I'm* an animal, and I say—"

The argument continued, sotto voce.

"What a big—" Deede was having her turn at the game, but Gina had seen where her eyes went, and had an odd puritanical streak. "Captain," she stopped the play in the simplest manner, by asserting adult authority, "when did you say the Periphs were expecting you?"

"When they see me, of course. You know how it is, all the jokes about space-traveling salesmen."

"And the farmers' daughter," Peach Blossum giggled.

"M'lady," an elaborate bow, "may I suggest that you're the most exquisite farmers' daughter I've ever encountered."

"Oh, I'll just bet you say that to all the girls," she simpered in an exaggerated fashion, winking at Jomo.

"Only," an even deeper bow, "when it's true."

"Which it always is," Gina's voice was dry.

"But of course," he turned the bow on her, appreciating graceful height and neat curves, "what could be more exquisite than what I see—right—now."

"Oh, Gina," Peach Blossum pouted, shaking her head so that the close cropped silver curls danced, "don't spoil it. What *do* you sell, Captain?"

He shrugged. "Whatever people need." He looked around, assessing the

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Central console and its attendent analyzer, organic molecule builder, recomb lab, contained subforce power pack and transmuter; also the hand-woven rug on the pounded dirt floor, and the scanty furniture carved from some local natural material, the ax marks showing plainly.

"Now, I'd say you people are pretty cosy and snug here. But I picked up a neat little spinner/loom on Hindsight—" (No need to mention exactly how he'd "picked it up.") "—doesn't even need a separate power supply, just plug it into your control Central. All you need to do is keep the supply hopper filled, any kind of raw fiber will do. It can be programmed to produce yarns of specified thickness. It mixes its own dyes—comes with a guaranteed minimum five styears supply, and when they run out, it's easy enough to program a little Mark VII organic lab like you have here for more. The cloth can be woven in any texture, or width up to three meters, and—"

Everybody looked at Ulysses, though Menachim was the official decision maker for the day. Ulysses shook his head. "Thanks, but no thanks, Captain. We're pretty self-sufficient here, what little gencred crop we raise goes to maintain minimum insurance. Weather, essentially. I can check the data in our Central, if you want, but I'm pretty sure we haven't enough gencreds to spare for a loom like that."

"But, you know, to set up a demonstrator on this planet, so that your neighbors could see how useful it is, I could set you a generous price. More than generous, to match your own generosity. No commission for me, not even a travel charge."

"No," Ulysses continued to shake his head. "Sorry, but—no."

"I can set up a percentage payment plan, you know, so much a growing season—" A genuine salesman wouldn't have given up at this point, and the pirate was shrewd enough not to, either.

"Sorry, no, no debts. This family doesn't run that way."

"How about a preservater. Preserves and seals any organic for a minimum of two styears. Irradiates it, eliminates all harmful life. Runs off your power pack, and—"

Ulysses was still shaking his head.

But because they had refused to buy from him, they all felt an obligation to extend even more hospitality.

"So you have a dragon of your very own, do you," the pirate said to Juney, after a stomach-stretching meal that did Euphony (at least in their own minds) proud. "Oh, come now, that's only in story programs."

"But I do! He's big, and he has wings—well, they look like wings, and—"

"And teeth this big, and he breathes fire," the pirate finished, straight-faced, but winking with his back eye at the adults.

"He doesn't have teeth," Juney was disgusted at such ignorance. "Just a mouth this—" He stretched his arms wide. "—big. And who ever heard of a dragon that breathed fire?"

"Most of them do, in the story programs."

"Story programs are for babies. Even Johntrude knows better. Besides, if he breathed fire, what would happen to the crops in the dry season?"

"Enough he tramples them, in any season," Ulysses muttered.

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"I understand, kiddo. You have some local animal you call a dragon."

"Mustard *is* a dragon!" the three older children chorused.

"If you say so." Another wink for the adults.

He is, he is, come on!" Hands pulling at larger adult hands, pushing broad back, the pirate was escorted out the door by three vociferous younglings, all talking ten-a-second, before the adults could react.

Copper sighed and picked up Johntrude to put him/her to bed, with a Central supplied hypnohum to keep the child quiet. (He she was really too old for either nap or the babyish hum, but he/she was small and undeveloped for his/her age—another side-effect of the gene manipulating process—and habit was strong. The "baby" would remain the baby until a new baby came along.) Meanwhile Ulysses was muttering to Jomo. "Only hope the idiot animal doesn't step on him."

"Fat chance," snorted Jomo, who'd taken a dislike to the looks continually being exchanged between Peach Blossom and the stranger. Much more, and the "traveling salesman" would be sailing out tied to the tail of his own spacer! The marriage was sexually adjusted, and had gone through a great deal of effort and computer analysis to attain that adjustment, and if this out-of-the-black spaceboy thought he could just walk in and throw that precious adjustment out of kilter, for the sake of a night's comfort, let him learn different! Besides, who ever heard of a spacer who didn't travel with an amadroid or *something* in his life-support pod.

"Dragon or not," the pirate's head was cocked well back to survey Mustard in all his yellow-brown glory, "dragon or not, that's one of the biggest non-aquatic indigenes I've ever seen."

"They're not intelligent," Gina informed him.

"Intelligent," Ulysses spat with practiced ease, his spittle discolored grey-green from a local leaf the adults liked to chew. The pirate would have winced, if he hadn't been so occupied with Mustard. "It eats, sleeps, and sh—provides organic fertilizer. That's as high as its *intelligence* can manage."

"Besides," Menachim added. "You know the Law. No colonization where there's an indigenous population over .9 on the Goodall-Lilly scale. There's nothing here over .5 or so."

The pirate shrugged. "Surveys have been wrong before."

Ulysses snorted. "Not here. This lump isn't even as intelligent as a gaw—that's a flying predator we have—or a loke—another flying predator, that travels in huge swarms. You should see his—ha!—nervous system, the ratio of nervous tissue to—"

"The incomplete plexi may indicate that's he's immature and may yet develop—" It was an old argument, everybody knowing his or her cue. Gina led the "he-may-develop-yet" contingent.

"He's mature enough everywhere else, and he can't grow any bigger. The square-cube law won't allow it."

"But disconnected, incomplete plexi . . . and so close to the surface . . ."

"Idiot animal! Designed by an idiot, too!"

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"Why does he only seem to have scales on the lighter stripes?"

Juney grinned. "They're heatproof, sort of." Asbestos, one of the adults inserted. He seems to like to chew rocks . . . the asbestos winds up in the scales. . . . "When it gets hot, he folds his wings—well, not wings, that's just what we call them. Anyway he folds them so that only the scales show, to make a heat-proof umbrella. . . ."

"He eats rocks?"

"He eats anything he can get that big mouth around," Ulysses answered. "Including our crops. Mostly, he just shovels it in, almost blindly. The odd rock or two included winds up in a sort of bird-craw masher in his digestive tract, and useful minerals go places like the scales. But most of what he eats is organic. If it goes in, it gets digested. Food is food."

"He must need a *lot*." The pirate rubbed his chin and changed his plans.

"You'd better believe it." Ulysses glared at Mustard, still cowering in the corner, despite the children's efforts to coax him out with several of his favorite treats.

"Well, maybe if you had a younger specimen . . . are they very common around here?"

Ulysses shrugged. "They're rare. And as for younger specimens, nobody's ever seen any. And we've got too much to do, to worry about chasing down the life-cycle of a non-essential like Mustard."

"If he's non-essential, why do you keep him? Mighty big kids' pet. And isn't that appetite a little dangerous?"

"Only if you crawl into his feedbox." Ulysses shrugged again. "And he's cheaper than using energy to run our processer to convert garbage to fertilizer, which is why—" A glare at the children. "—we keep him around."

"And no smaller specimens," the pirate persisted.

"Ten, twenty percent smaller, maybe. But they all seem at the same stage of development. Told you, about his life-cycle, we don't know, and don't much care either." Gina sniffed, and Juney glared.

"Oh." Mental shrug. So much for the zoo idea; even quickfrozen and thus not eating, that was too much mass for a profitable haul. But maybe . . . He turned, put one of his fancy boots on a "Dragon's egg"—and made a one-point (shoulder) landing in the barnyard mud. His curses were almost as loud as Ulysses' furious scolding of the children. "What the Wheel is this thing," the pirate interrupted Ulysses' tirade to ask.

"Dragon's egg. I'm sorry, here let me help you up. Those fool kids, they know they're supposed to keep those fool things away from walkways."

"Dragon's egg." The pirate held it, turned it slowly, in a puzzled manner. "That thing lays them?"

"No, he doesn't *lay* them. They don't seem to be eggs, either, it's just what the kids call them. They're organic waste of some sort, but hard and smooth, as you've discovered for yourself. The kids use them for all kinds of games."

"And are these," the pirate still seemed puzzled, "the only Dragon's eggs around here?"

"Far as we know. For all we know, Mustard reproduces by fission or budding or something similar. We don't

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know his life cycle, as I said; though he does seem to have sex analogs."

"No dragon and no Dragon's eggs," the pirate muttered. "I'm going to get *something* for this trip. . . ."

"What did you say?"

"That I was really interested in your farming methods."

He couldn't have picked a surer way to Ulysses' heart. The rest of the afternoon was spent showing off the programmable and Alter-controlled farm machinery, the irrigation network, the sunscreens, the winter shelters.

"Extremes of temperatures here—hot summers, cold winters?"

"Aye, that you'd better believe it. That's probably why we have so many winged species. They migrate, the animals that can't hibernate in the winter and estivate during the summer."

"Like your dragon?"

"In the deepest heat of summer, he goes nocturnal mostly. In the winter—who knows. He wanders away when the first frost hits, and back in the spring. I'd say he has to hibernate, can't feed all that bulk through our winters. We have—*Oh, Mother! Swarm warning, swarm warning!*" He had shouted the latter into his comm. Immediately a klaxon howl resounded over the farm.

"What's the mat—"

"In here!" He flung the pirate into the control cabin of the multipurpose vehicle that control Central had sent roaring up, and the doors clanged shut behind them.

"I think," between pants, "we got that warning up in time. Those cursed locusts!"

"What are they?"

"Look." He pointed to a viewscreen, where the sky was getting suddenly dark. "The first swarm of the season. Lokes. Locusses, some call them, and they're enough to make a farmer weep as well as cuss, let me tell you. They're an animal, a small animal, about the size of a human's little finger—but they're 90% mouth, and they swarm in—in *swarms*—in the hundreds of thousands, millions. Mother alone knows. Flying appetites. Without warning, they can strip a human to a skeleton in minutes, a crop to the ground in hours. And cussed little you can do, once the bulk of the swarm lands. But if we can spot them *in time*—see there—and there—" On the viewscreen, surrounding and making a regular mesh through the farm, were a network of tiny whirling dust devils.

"Our protection system. Artificial updrafts. What you're actually seeing is dust caught in the turbulence surrounding the updrafts. The lokes are light, more glider than true flyer. They can't fight a strong air current. So the updrafts protect us. But it takes a *lot* of energy to maintain, we can't afford to keep it on *all the time* during swarm season. So we watch—eyes and instruments, each backing the other up—and hope. Now it's established, it'll stay on until one of us clears it, once the danger is over."

"Is it safe to go out in the open now, or do we have to wait until the swarm is past?"

"Reasonably safe, once the updrafts are enforced. Just watch out for your eyes. A few of the little devils do manage to get through. They can take a sizable chunk out of you, hurts like blazes, but no trouble to fix, unless it's your

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eyes. So stay alert."

"I will. Those little whatsits—they good to eat?"

"If you like bootsoles."

But bootsoles wasn't what they served for the late supper, the farm did itself (in its own eyes) proud a second time, all its own produce. (But nothing, the pirate was thinking, worth the fuel to haul to a *civilized* market, even considering the prices paid for rare "exotics.")

After the meal, he was beguiled with home-produced liqueurs. But while his mouth was smiling and making polite conversation, his brain was worrying away at a paradox.

Amber "Dragon's eggs" of known organic origin, so common kids play with them; and deep plum balls called "Dragon's eggs" believed organic in origin, planet of origin unknown—but a lot of clues pointed at this one. Rare "Dragon's eggs," deep-plum colored —which, when rubbed against the warmth of human skin, produced a euphoric/hallucinogenic reaction that beggared any other drug known, with no bad side effects. There had to be a connection—hadn't there?

He probed with his casual questions, but nothing made a pattern. Dragon's eggs kept in the house lasted indefinitely. Dragon's eggs left outside quickly disappeared. Eaten by something —possibly Mustard—was the consensus.

Then he got it. Most space cargoes were quick-frozen. If some of the local Dragon's eggs had gotten mixed in with a bulk cargo . . . if it was the freezing that turned them into real "Dragon's eggs" . . . *yeah* . . .

Ulysses was hinting that it was late and farmers need their rest; and that he, the pirate, would undoubtedly sleep more comfortably in his familiar environment, the ship. Not even *hospitality*, the pirate sneered to himself. Well, he was going to take care of that. . . .

"You're right," he grinned, "it's time I collected what I came here for, and left."

"What you came here for?" Ulysses was slow in reacting, but Jomo the jealous wasn't. "Guardian—" he spat.

"Too late," the pirate continued to grin. "Guardian program, do you recognize this?" He opened his hand, very slowly; in it was an innocuous milky-colored oblong.

"It won't do you any good," Ulysses growled. "The Guardian program can freeze you before you complete any threatening move."

"I don't intend to move a muscle, not yet. But ask your Guardian exactly what I'm holding, before any of you does something foolish."

888 B-PRIME DEADMANNED SPLITTER, FULLY ACTIVATED

"Which means?" Ulysses asked impatiently.

IF I PARALYZE HIM, THE SPLITTER WILL AUTOMATICALLY FIRE. HE IS STOPPING IT FROM FIRING NOW. IF HIS THUMB RELAXES, AS IT MUST IF TOUCHED BY PARALYZING FREQUENCIES, THE SPLITTER WILL FIRE. ALL HUMANS IN THE ROOM EXCEPT THE INTRUDER WILL DIE, OF IRRETRIEVABLE INJURY. THE INTRUDER IS PROTECTED BY A TINY SAFETY VOLUME AROUND THE WEAPON. I CANNOT PROTECT YOU. I SUGGEST IMMEDIATE EVACUATION

"No," the pirate continued to grin.

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[illegible] even looks like he/she's [illegible] get out a door, I let loose. You [illegible] either way, chumps. You [illegible] what I want, all I want, and I [illegible] get loose, and take what I [illegible] loose. You'll all be too dead [illegible] Alive or dead. I get what I want. Your choice."

"But how could you have smuggled that thing [illegible] Ulysses still hadn't quite taken it in.

"Farmboy, your exterior defenses are pretty good. I could have wiped your farm off the face of this planet in half a day, easy, but no way could I have taken it intact. But your interior defenses, especially after you identified me as 'pirate'—" He shook his head. "A baby could fool 'em. No," he thought it over ostentatiously, "not a baby. Let's just say someone with the necessary experience."

"All right." Gina was always the practical one. "What *do* you want?"

"It don't matter to a corpse what he still has or doesn't have."

"All right." She nodded. "Central, [illegible]"

The pirate's smile broadened. "You [illegible] I was programming [illegible] into a Central. I'd [illegible] that activated [illegible] the main one was [illegible] those who [illegible] [illegible] [illegible]

They lobotomized the farm, and themselves. And all the small, miniaturized specialized equipment, too, the analyzer, the transmuter, the— Piled up, it didn't take much volume, all the portable wealth they owned. Packed into a float with a Follow-me that the pirate genially dropped into a pouch on his breechclout belt.

"Is that—all?" Ulysses' eyes were hollow. It was his family's future piled on that floater.

"All . . . most." This was what he loved, the real reason he was a pirate. Not for credit, he already had more than he could spend in an artificially elongated life. But for this—those short moments of absolute power over other human beings. His eyes scanned the room they had returned to, his mind ran over the list he'd made of usable outside equipment. Yes; he had it all. Except . . . the four children had retreated into a corner, with Peach Blossum murmuring gently, trying to calm them.

Peach Blossum. He knew he had forgotten something. He was well aware that she had been flirting with him only out a spirit of mischief, that these hicks wouldn't have thought of offering him real hospitality.

Now they won't have any choice.

Not that he had any intention of keeping her as far as the next world, either—give her a chance to rat on him? Nah. But—she'd be amusing while she lasted.

Carefully he used his free hand to pull out his real weapon, a mind-linked energy projector that could spew out paralysis, mind wipe, pain, or death in a dozen forms, quick as his thought. He adjusted it on his head; the base fitted around his reverse tonsure, like a king's crown in the old story programs. The rest of it, the swivelling antenna, projectors, rode above his hair like some strange insectoid second head.

The family stared at it numbly; even when he clicked the splitter loudly off and dropped it into his pocket, nobody moved. They all knew very well what *this* weapon could do.

"All of you, on your feet. I'm keeping you under my eyes until the last second."

"What can we do *now?*" Jomo challenged. "No brains, no power, no nothing. We can't call, we can't ride anything. The nearest farm is a dozen kilometers from here, it'll be hours before we can walk there. By then you'll be long gone."

"Because I'm not going to leave all of you." His finger pointed. "You, pretty farmers' daughter. You're going on a long ride with me."

"NO!" Jomo attacked, and joyously the pirate gave him a nerve bath, so that he collapsed screaming, every nerve in his body inflamed, jerking in a helpless, epileptic frenzy.

"Any other fools among you?" the pirate inquired genially.

Menny and Copper knelt on either side of the howling, convulsing victim. "What did you *do* to him?" Menny asked.

"Nerveburn. It'll wear off— eventually. May need some minor transplants, but there'll be no permanent harm done."

"*Do* something for him," Copper demanded.

"Can't. Nothing even a major hosp

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could do—except stick something hard in his mouth so he won't bite his tongue off and drown in his own blood. Other than that . . . Copper scrambled over to the serving table. They had served small amounts with the liqueurs, and some of the serving pieces, forks and spoons, all made of hand carved wood analog, were still on the table. She forced a large spoon into Jomo's clenching mouth.

Nasty, brutish . . . the pirate was jovial. But that's the big leagues, hicks. Anybody who don't want to learn the facts of life the hard way." He looked around, knowing they were all hating themselves for cowardice, while sensibly grateful for him to make the mistake he knew he wouldn't.

"Right then, pretty farmers' daughters. Come along then. And the rest of you, form and march!"

The ruins of the farmyard were almost unchanged. It was hard to believe only a few hours had passed. The night sky was filled with an auroral display.

Mustard heard the humans plodding along the path from the main buildings to the field where the spacer had landed. He was getting unusually hungry. He bleated.

The pirate snapped his fingers. "Almost forgot. Want a small chunk of your livestock, pet? I can sell it to a zoo—or they'll put them along their exhibits." The protector hovering over his head swung around menacingly. "You all stand there in a group while I slice off a sample. Remember, I'll be watching you—and this protector has no reflexes."

An angry family watched him stride toward Mustard, angling so that he was approaching from the side.

Him and those cursed eyes in the back of his head," Ulysses murmured. "When he gets close to Mustard, Peachie—you run!"

"He'll just take somebody else."

"We'll all run, then—he can't catch all of us."

"He only needs to get one. Suppose he goes off with Deede—or Juney. We can't risk it—" Unutterable anguish. "Don't you see, we *have* to do whatever he says."

The pirate, who had augmented hearing, smiled. Mentally he programmed his weapon to slice off a fist-sized chunk of flesh—

"SWARM!" screamed Gina. "DROP!" The family dropped, wrapping themselves in the cloaks that were designed for their world. Peach Blossum, who was nearest Johntrude, grabbed him, her and rolled the screaming child under the protection of her own cloak. Ulysses checked Deede and David, who had been standing next to him, before he protected himself. Copper likewise took care of Juney before herself.

The pirate had moved to between tail and rump, heard the shout, looked up—and saw a multitude of grey cobwebby objects zeroing in on him. Mustard howled, as he lost a kilo of meat and hide, and then the pirate's weapon flared out among the swarm, and crisped ashes dropped around them like a black blizzard.

Mustard howled again.

The corpses piled up, on the ground, on Mustard and the pirate, his weapon still sweeping a narrow cone of sky above his head.

Mustard howled a third time, behemothian rage. And—his tail moved, slammed up and under the startled pir-

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ate, who had been concentrating on the danger from above, one pair of eyes up and scanning, the other, of necessity, pointed down.

He didn't see the moving tail until too late.

Only Deede, who had cracked up the edge of her cloak to keep an eye on her beloved Mustard, saw what happened next.

The tail struck, and the pirate, weapon still flaring, skidded up the curved rump, the tail urging him onward. A trail of seared flesh followed him as his weapon continued to discharge. Then Mustard's wings made a huge sphere—and collapsed inward.

There was a hideous scream that died away in mid-note, then a thump-chuff as some heavy object hit the ground and was trampled into it.

Deede watched, eyes and mouth wide in amazement.

The swarm circled Mustard's head like a miniature tornado, there was a high sweet humming that might almost have been singing—and then they were lifting, lifting, flying higher and away—

"They're gone," Deede announced loudly, "and Mustard—Mustard—"

"They can't be," even muffled, the impatient voice was identifiably Ulysses'. "They can't have stripped the place in a few seconds."

"They are, they're gone. Mustard, he—"

"They can't have eaten him, either—unless he hadn't enough sense to get into the barn. Mother! I forgot, without the brains, the doors won't have closed behind him. Maybe I can—" One of the cloaks began crawling slowly over the ground.

"Mother protect us," Gina exclaimed. "They *are* gone!"

The crawling cloak stopped and Ulysses peeked cautiously out. "They are! I never heard of them leaving before they stripped a place, not once enough of the swarm got in past the defenses."

"Mustard did it." Deede insisted, and then they were all peeping out and then sitting up, looking around in puzzled wonder. "Good ol' Mustard." Deede ran and hugged him. I'm *hungry*, he bleated.

"Then . . . the crops are still all right . . ." Ulysses couldn't understand their unprecedented good luck.

"And—*Captain* Liar Wyzsynski, where—" Gina hadn't forgotten the Prime Enemy.

"I don't know," Menny had been looking, too. "Maybe they ate him," he decided in satisfaction.

"No, they didn't," Deede was still hugging her pet and mourning over his wound. "Mustard got him."

"What?!?" "How?" "*Mustard?*"

"That's what's left of him," the child pointed.

"Mother protect us," the adults gathered around a muddy patch where *something* large had been trampled shapeless and half-buried. "It does . . . look like . . ."

"It is." Deede was sure. "Mustard did it."

"She may be right." Copper had turned to the dragon. "On his back, here, this isn't where the swarm might have gnawed, this is a burn. . . ."

"He knocked Nasty Tuffy up on his back, and then he made a *big* globe with his wings, and then—he squeezed down, *splutch*! And then he dropped and

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stomped on what was left."

"Made a big globe . . ." Gina frowned, thinking.

"And then a little one."

"We know how tough those wings of his are." Gina was still thinking out loud. "And if he folded them to make a reflector surface, and then squeezed down . . . especially if he was holding them tightly together, making them airtight . . ."

"Are you saying he knew that the energy from the captain's projector would reflect off those asbestos scales and fry him?" Ulysses demanded incredulously.

"No. I suspect it's a reflex, to get rid of tasty smaller predators. The captain's frying himself—if that's what happened—was just an unexpected byproduct. No, stop and think. Mustard's wings are about twice as wide as he is long. They'd make a rough sphere about, ohhh, 30 meters in circumference. Shut it, he shrunk that sphere down airtight and no heat leaking . . ."

Unfortunately, Menny considered it. Temperature and pressure would both go up.

"Enough to stun a smaller animal long enough for Mustard to step on it and finish the job. We did wonder why that extra energy lobe at the base of his tail. Now we know." Pause. "What I don't understand is why'd the swarm save?"

Gina took his thumb out of his mouth. "Human parents don't eat their children, do they? Or children their parents."

They turned to stare at him/her.

"Except I could hear them? I could. In a way, separates. But when they're big enough, they'll become wholes, like me. Mustard's too young now, but later . . ."

"What do you mean," Gina asked, "you *heard* them?" (But Copper looked at Menny, who nodded.)

"Heard them. No, not heard. They—they were trying to *join* Mustard, to become complete, the whole they should be, only they can't cause Mustard's too young. And I joined with them somehow, maybe 'cause I'm complete, or maybe because making me a complete did something to my mind. I don't know. But while they were trying to join, they *knew*. And I knew, too. They've already forgotten, and Mustard, too, mostly, but when the right time comes, they'll remember. But 'course they wouldn't eat the crops. Mustard may need them. And they're Mustard's—not Mustard's, he's too young. But they're the children of what Mustard will be like when he's whole, and when he becomes whole, they'll be his wife and his mind."

Slowly, in his/her child's vocabulary, Johntrude tried to explain, while they all went back inside to see what could be done—unfortunately, not much—for the still pathetically jerking Jomo.

"What we call Dragon's eggs, they really are. Eggs, I mean. Only Mustard's not old enough, he's not complete, so the eggs can't—they aren't—"

"Fertile," one of the adults supplied.

"They can't make lokes. Yet. When Mustard's ready, that's what'll hatch from them, a swarm. See, when Mustard's ready, when he's bigger, lots of little pockets develop, all over his skin. And a lot of lokes'll go there, and live. They'll be part of Mustard. He'll be

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complete. And they'll make more mind for him, too—"

"Those incomplete plexi!"

"Yeah. And when he's complete, he'll go with another dragon, and he'll be daddy to the other dragon's eggs, and the other dragon'll be daddy to his. And the egg'll be—whatever—then. They'll hatch, into lokes."

"You—mean—the lokes grow up to be dragons?" Ulysses asked.

"Not 'zackly. Some of 'em'll join dragons that are ready, become self-brain-wife. The rest'll join together, inside a—a giant shell, south, where it's warm. And they'll sleep, and grow together, and change—all through the winter. And when spring comes, the shell'll break, and out'll come a dragon. The more lokes to start with, the bigger the dragon. He'll be like Mustard, incomplete, but he'll eat, and grow, and grow, and eat . . ."

"Mother, what a life cycle," Gina mumbled. "Metamorphosis, growth, symbiosis, sexual union, eggs, sexless . . ."

Through the open door, they could all hear Mustard chomping away.

"We'll have to send Mustard away," Ulysses announced.

"Not Mustard," Deede wailed, running out to hug her pet.

Several of the adults and all the children followed her out, the rest still caring for Jomo as best they could.

"Why?" Gina asked.

"Too dangerous. Suppose he does to one of us what he did to that anti-mother."

"He won't." Johntrude was sure. "He knew what he was doing."

"You mean—he was protecting *us*?"

"No," a giggle. "He was protecting *them*. His children. The swarm."

"*Well*." Gina had always been Mustard's chief defender among the adults.

A shrug. "On your head be it, wife."

"But you're going to send *me* away, aren't you?" The child's face was suddenly ancient—and incredibly sad.

"No, we're not." It was another challenge. Gina looked around, but nobody else spoke. "Not for a long, long time, anyway, Johntrude. Not until we've completed you children into a sextet or an octet, and you're all grown up. Then we'll send you away, to start a farm of your own. But we'll send all of you, you and Juney and David and Deede and the ones we haven't chosen yet. But you needn't worry about going away, not for a long, long time. Smart people learn, when they almost lose something, how much they *really* value it." Another glare all round. "And the next child we choose will be another complete, like you, just so you won't be the only one. And I don't care how many gencreds it costs us, or what the profit projection says."

Ulysses laughed. "You know," he tossed one of the amber balls into the air and caught it. "If these really are Dragon's eggs, then they're sort of seeds, too. I was thinking of an old saying, about having faith as in a grain of mustard seed—but if this is a mustard seed, what we really should have had faith in was the *Mustard* . . ."

He cursed and leapt aside, but not quickly enough. What comes in must go out.

"At least," Gina could hardly speak for laughing, "you've got plenty of Mustard seeds to base your faith on." ■

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6-8 March
WISCON 5 (Wisconsin area SF conference) at Madison Inn, Madison, Wis. Guests of Honor—Chelsea Quinn Yarbro (pro), Buck and Juanita Coulson (fans), Don and Elsie Wollheim (editors), Teresa di Lauretis (critic), Steven Vincent Johnson (artist). Registration—$10 until 28 February, $12 at the door. Info: SF3, Box 1624, Madison WI 53701.

8-12 March
Fifth International Conference on Software Engineering (SIGSOFT-ACM, NBS, IEEE-CS) at San Diego, Cal. Info: Dr. Leon G. Stucki, Boeing Computer Services Company, P.O. Box 24346, Seattle WA 98124.

13-15 March
MARCON 16 (Central Ohio SF Conference) at the Columbus Hilton Inn, Columbus, Ohio. Guest of Honor—Andy Offutt, Fan Guests of Honor—Bob and Anne Passovoy, Toastmaster—Jody Offutt. Registration $10 until 1 January 1981. Info: Liz Gross, P.O. Box 2583, Columbus OH 43216 614-497-9953.

16-20 March
General Meeting of the American Physical Society at Phoenix, Ariz. Info: American Physical Society, 335 East 45th Street, New York NY 10017.

20-22 March
LUNACON (NY area regional SF conference) at the Sheraton Heights, Hasbrouck Heights, N.J. Guests of Honor—James White (writer), Jack Gaughan (artist). Wargaming, art show, etc. Registration—$11 until 28 February 1981, $14 at the door. Info: Lunacon '81, P.O. Box 204, Brooklyn NY 11230.

23-25 March
Office Automation Conference (IEEE) at Houston, Tex. Info: Office Automation Conference, AFIPS, P.O. Box 9659, Arlington VA 22209. 703-558-3617.

2-7 September
1981 DENVENTION II (39th World Science Fiction Convention) at Denver Hilton, Denver, Colorado. Guests of Honor—C.L. Moore and Clifford Simak, Fan Guest of Honor—Rusty Hevelin, Toastmaster—Edward Bryant. Registration until 1 September 1980, $25 attending, $15 supporting. This is the SF universe's annual get-together. Professionals and readers from all over the world will be in attendance. Talks, panels, films, fancy dress competition, the works. Join now and get to nominate and vote for the Hugo awards and the John W. Campbell Award for Best New Writer. Info: Denvention II, P.O. Box 11545, Denver CO 80211. 303-433-9774.

—ANTHONY LEWIS

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Part Four of Four Parts

LEE CORREY

SHUTTLE DOWN

Ancient problems will undoubtedly follow man into space as soon as he goes. But that's no reason not to go!

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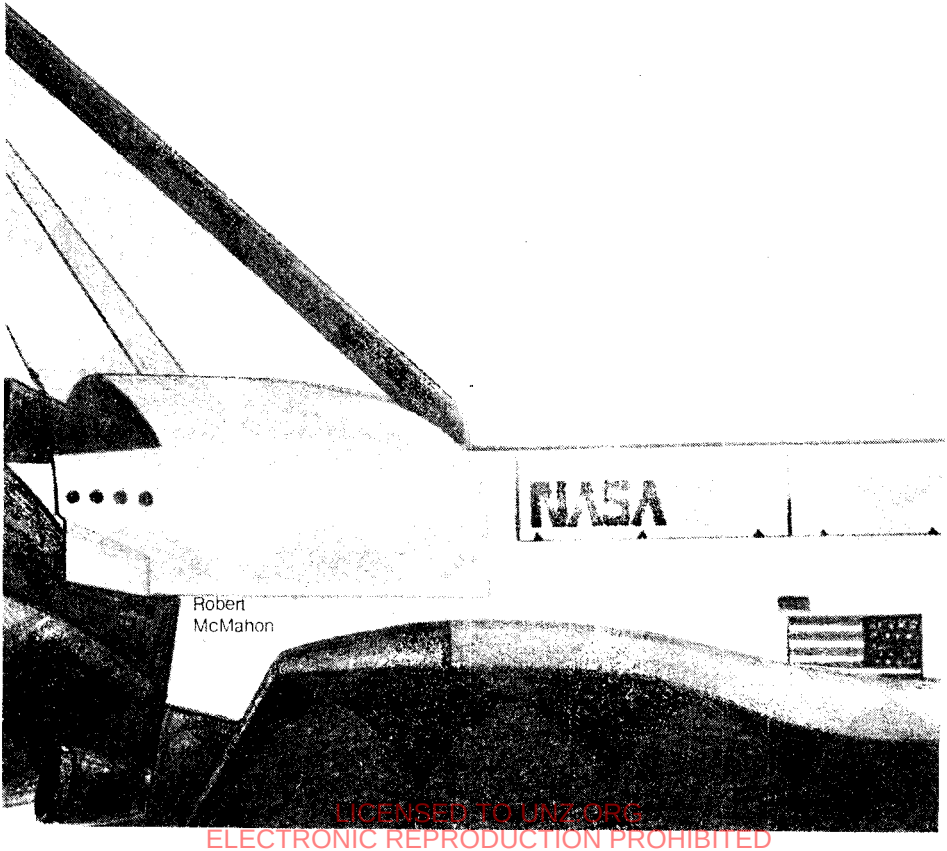

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SYNOPSIS

After the NASA Space Shuttle Orbiter OV-104 Atlantis *makes an emergency landing on Chile's Easter Island (Isla de Pascua) in the South Pacific, Shuttle Commander FRANK KING and his crew—co-pilot LEW CLAY, payload specialist HAP HAZARD, and mission specialist JACKIE HART—are greeted by the military governor, CAPTAIN ERNESTO OBREGÓN. The NASA recovery team led by Mission Manager RED RICHARDSON and accompanied by NASA Public Affairs officer CASEY LASKEWITZ and State Department Latin American expert JOYCE FISHER manages to get to Isla de Pascua by Air Force cargo planes in spite of the fact that NASA has no "contingency landing agreement" with Chile. Through the efforts of JOYCE and her boss, ALFRED M. DEWEY, the Chileans allow the Americans to come in with Air Force transport planes to recover the* Atlantis *after certain "conditions" are met.*

In an attempt to eliminate American competition in space industrialization, the Soviet Union accuses the United States of trying to orbit a military beam weapon satellite in the Atlantis. *Intelligence sources and recon satellites report two modern Soviet naval vessels have left Vladivostok headed toward the South Pacific.*

One of the "conditions" demanded by the Chileans is an inspection of the Atlantis *by a Chilean commission in order to protect Chile against Soviet claims.*

The crew of the Atlantis *has to wait on Pascua until the initial planes arrive. Frank becomes close friends with American-educated Captain Ernesto Obregón, and Lew and Jackie strike up a more-than-platonic relationship. After Joyce untangles bureaucratic red tape in Santiago, the initial rescue party headed by Red with Casey, Joyce, and two reporters, Alice Arnold and Herb Haynes, arrives on the island. The toxic residual propellants aboard the* Atlantis *are safely drained from the Orbiter, but a confrontation ensues between Obregón and Richardson over authority. The NASA manager feels that Obregón is trying to run the show, but Obregón tries to explain that he will have to handle the problems caused by the Americans long after they leave. In addition, Obregón will not let Richardson send the crew of the* Atlantis *back to Houston until the Chilean investigating commission has had a chance to question them. Not all of the personality conflict between these two men is resolved by a direct confrontation and the diplomatic intervention of Joyce, who understands what motivates both men.*

The recovery operation gets under way as the Atlantis *is moved off the runway, permitting more planes to arrive with equipment to expand the airfield and bring in a tent city to house the more than 150 people required by the recovery operation plus representatives of the news media, who are tactfully handled by Casey. A communications satellite ground station is set up on the island, ending the isolation and putting Red and Joyce in contact with Houston and Washington again.*

In order to head off any Soviet naval pressure on Isla de Pascua and Chile, the U.S. Navy dispatches a task force consisting of the carrier Kitty Hawk, *the guided missile cruiser* Halsey, *and*

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the guided missile frigate Cochrane.

The Chilean investigation commission consisting of Chilean Naval chief ADMIRAL MONTERO, *Chilean Air Force* COLONEL RIOS, *and Chilean aviation expert* PROFESSOR PEREZ *arrives on Pascua and is given an open tour of the* Atlantis *by Frank and Hap. After an extensive but diplomatic grilling of the crew, the commission retires to determine its report to the President of Chile.*

Finally, the plane carrying the news media people arrives along with the first heavy-lift cargo planes, the C-5 Galaxy transports. Casey's job becomes as intense as Red's.

Alex Arnold attempts to seduce Frank, who, happily married man with children, gently rebuffs her but, during a night walk among the Easter Island statues, runs into Joyce whom he finds in a most servile aircraft. Although Frank feels guilty by worries about the effect his affair with Joyce will have on his marriage to the woman whom he loves very much.

The Chilean inspection commission makes its verbal report before the world's press on Pascua, coming to the conclusion that there is no military aspect to the flight of the Atlantis. *Admiral Montero and Colonel Rios board a USAF C-5 Galaxy to fly back to Santiago to make their formal report to the President of Chile.*

As the C-5 carrying two of the members of the Chilean commission takes off and climbs eastward away from Pascua, Frank King is the only person who is looking when the airplane explodes in the sky.

* * *

CHAPTER THIRTEEN

Frank was the only one who saw the explosion of the C-5 Galaxy.

It was really quite typical of unexpected happenings. There were more than a dozen TV cameras on the ramp, but not a one was following the departing transport. There were dozens of cameras, some with long lenses on them, but not a single photo was taken.

Colonel Matt Hubbard reacted to Frank's sharp intake of breath and explosive expletive. But Hubbard saw only the fireball.

Others reacted to the sharp flash of the explosion. And still others didn't notice until the thunder rolled over the airfield long seconds later.

And Frank was the only one who had the presence of mind to react to the situation. Without taking his eyes off the expanding cloud of smoke, flame, and debris, he reached over and tore Herb Haynes's portable tape recorder away from the reporter, who was so surprised at the action that he released it without hesitation. Frank noted the position of the explosion with reference to landmarks, pushed the record button, and began to dictate what he thought he'd seen. He was still talking when the full realization of what had happened spread over the crowd and erupted into shouts, screams, yelling, and a panic attempt to capture the aftermath of the explosion on record.

"I don't know what happened first," Frank told the recorder. "I know the right wing appeared to separate, followed immediately by the left wing inboard of the Number One engine. This may have been the result of the explosion which appeared to have brisance

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quite unlike the explosion of fuel tanks. But all fuel aboard probably burned because of the large, long-lasting fireball. I don't know whether the accident was caused by a bomb aboard the plane, by a malfunction of the fuel system, or by some structural failure . . ."

"That was my C-5!" He turned to find Colonel Matt Hubbard still standing beside him, his face as white as a sheet. "I was supposed to be flying the left seat on that plane," he muttered. "I turned it over to Jimmy to fly the round-robin to Santiago . . . Damn it! God damn it!" Matt was shaking.

"Easy, Matt," Frank tried to calm the man. Colonel Frank King had been in similar situations in Viet Nam where pilots had died because they'd flown for friends who were unable to take the fatal mission. That sort of thing was always a shattering experience. "There was no way you could have known it would happen."

Ernesto Obregón was at Frank's right. "Frank, you saw it all?"

He nodded. "I did."

"My Admiral was aboard! I'm sending the boats out to search for survivors," the military governor said. He crossed himself and muttered something in Spanish. He, too, was shaken . . . and Frank had not seen Obregón shaken before.

"You won't find any," Frank told him bluntly. "That C-5 disintegrated. I didn't see any large parts fall out of the fireball, just little pieces. Nobody aboard could have survived . . . I'm sorry, Ernesto."

"I'll send boats anyway. They might find something. Was it a bomb?"

"I don't know. It could have been an equipment malfunction," Frank said.

"We've had wing troubles with the Galaxy since Day One." Hubbard admitted. "We fly it at cruise with the ailerons rigged ten degrees up to unload the outer wing. All C-5's have been back for retrofit on the wing structure, but they're getting near the maximum design life. And we've had continual fuel system problems, particularly with vapors in those big wing tanks . . ."

"Have you lost any others in flight lately?" Frank asked.

"No, and I've never seen one blow up in flight. It can't happen," Colonel Matt Hubbard said shakily.

"It just did," Frank reminded him.

"Governor, I'm posting my armed guards around all these aircraft immediately, and I'd like to have you put the entire airport under very tight security," Hubbard told the military governor, reacting at once to the possibility of both sabotage and terrorism.

Obregón nodded. "I was going to suggest it, because I suspect sabotage."

"So do I," Hubbard agreed.

"Ernesto, Matt, who's had ready access to these aircraft here on the ramp?" Frank suddenly asked.

"Your people . . . and some of mine," Obregón replied after thinking for a moment. "I think I know which of my people have been aboard . . ."

"Governor, nobody's going to come near these planes from now on except my crews," Hubbard snapped. "I've got two more C-5's on their way, and I can't turn them back. But once they're here, nothing moves in or out of Naples unless a picked team of my men goes over each aircraft. My load masters and cargo masters will handle all

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unloading and fuel transfer using my flight crews. And, Governor, please get all these media people off the ramp, not only for the security of the aircraft, but for their own safety. I don't know if there're more bombs aboard the planes parked here now!''

The media people were clustered around them. Obregón turned and saw the situation. Raising his voice, he shouted, ''Clear this ramp *immediately!* No questions, no interviews, or no speculations now on what happened! Get off this ramp now for your own safety! We don't whether or not it was a bomb, but these other planes here may be sapped!'' He turned to his Armada de Chile marine detachment, the departure honor guard for the late Admiral and Chilean Air Force Colonel. Orders were snapped in Spanish, and the platoon moved, removing 20-round box magazines from their belts and snapping them into their Swiss-made SIG510 rifles. The media people moved, some of them still rolling their video cameras and walking backwards toward the tower and the satellite ground station.

Joyce helped. He was a tall, gangling man who stood a head above most of the crowd. He waved his hands and motioned the media crews back. ''Let's go, gang. This ramp may be unhealthy. Come on, don't take chances. Talk and bitch and ask questions later, but not right now.''

Joyce fought her way through the throng looking for Professor Pérez and found him standing dumbfounded. She put her arms around him. ''*José, lo siento. He perdido a mi amigo también.*''

Joyce, I wanted to stay on Pascua to witness the full recovery operation,'' the scientist said in strained and halting English. ''If not for that, I would've been aboard . . .''

''I know. *Calma, calma.*''

''*Creo que estoy muy bien, gracias . . .*''

But Joyce sensed that something *was* wrong with the Chilean astronautics expert. She'd known him for a long time, and there was something different and atypical about the way he was reacting to the loss of his two colleagues. Under the circumstances, she temporarily dismissed the hunch and led Pérez off the ramp to the small building at the base of the tower.

There was a mob scene at the temporary building housing the satellite ground station. Casey was doing his best to keep some of the more aggressive media people from storming the station to file stories. But Casey couldn't make headway and was rapidly losing control of the situation when the crowd suddenly parted.

Captain Ernesto Obregón strode purposefully toward the door flanked by rifle-bearing Chilean marines. He stopped in the doorway and told the reporters, ''When I've reported this incident to my government and Miss Fisher has reported it to the United States government, we'll answer what questions we can. Then you'll be permitted to use the ground station in an orderly fashion under whatever arrangement you make with Casey Laskewitz.''

''You can't keep us from using this station. It belongs to the United States.'' As usual, it was Alice Arnold, stridently speaking up for her concept of freedom of the press.

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"On the contrary, it's Chilean property on Chilean soil . . . and as military governor I *can* restrict its use until we've completed official business. I don't want our governments to learn of this disaster from the newspapers."

"You're restricting the freedom of the press, Governor." It was little Marty Soloman, vociferous as usual.

Obregón sighed. "As I told all of you when you arrived on Isla de Pascua, you're on Chilean soil and subject to Chilean law. I'm the military governor of this island, and I told you I wouldn't deliberately be arbitrary. In this case, I'm not being arbitrary. I can't permit the limited communication capability here to be saturated when both the Chilean and American governments must be informed immediately."

"You're being arbitrary as hell!" Alice Arnold yelped.

"Be careful, Miss Arnold, or I'm likely to become *really* arbitrary, whereupon you'll find yourself on the next plane for Santiago . . . and I *do* have the authority to make it happen. No, leave your press card in your wallet; it won't do any good. Now, all of you please excuse me. *Professor Pérez, venga acá, por favor.*" And he disappeared into the ground station.

Joyce sat down on the metal treads of the stairway leading up to the control tower. "Oh, God what an awful thing to happen! And I've got to report it to Dewey when Obregón and Pérez get finished talking to Santiago . . ."

"Joyce, are we becoming involved with Chilean politics here?" Frank asked her.

"You mean, was that C-5 deliberately destroyed by Chileans—Marxists, left wing radicals, Cuban-inspired revolutionaries, or old Allende supporters—because it carried two members of the junta? Possibly. Quite possibly. But was it a bomb, Frank? Or was it a malfunction of something in the aircraft?"

"I don't know. I don't think we'll ever know unless Ernesto's boats pick up some pieces that'd confirm a bomb explosion when analyzed." He didn't know whether to ask Joyce about something that had occurred to him as he'd watched the orange fireball that had once been a graceful C-5 Galaxy. But he had to bring it up. "Joyce, if we're getting involved in Chilean politics, we've got to do something to bring it to a screeching halt right now. I don't know what either one of us can do about it, but I won't stand by and see the *Atlantis* jeopardized by political machinations . . ."

"We may have no choice, my space dreamer friend."

"Like hell! One regiment of United States Marines, and Pascua would be secured until we got the *Atlantis* away from here. Then the Chileans could have their volcanic rock back to play whatever games they wanted to!" Frank was angry, and his voice reflected that emotion. "This is costing us billions, and we've lost ten damned fine airmen along with a fifty-million-dollar airplane. And we've got an Orbiter worth several billions squatting here like a sitting duck. How long do you think Washington's going to stand still for that?"

"Frank, I hate to dash cold water on your idealistic view of the world," Joyce told him gently, "but I'm afraid I've got bad news for you. There'd

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[illegible] order from the Oval Office [illegible] Marines in here to protect [illegible] *Atlantis*. If it came to a choice between maintaining the existing Latin American foreign policy, such as it is, [illegible] part of the United States space program in the form of the *Atlantis*, can you guess what the decision might be? Which is more important to the Administration right now? And, if it came to [illegible] shutdown, what do you think would happen to us?"

Frank thought about that quietly for a long minute, reflecting what he'd just seen of the skies over Rapa Nui and [illegible] learning about its [illegible] affairs. "I think, Joyce, that you'd best get Mary Hubbard to get [illegible] out of there, just in case."

"[illegible] may not let them on the island. He won't like it."

"He won't know about it."

Obregón and Perez spent a long time [illegible] at the ground station shack. When they emerged, Obregón looked around at the crowd of media people. "I wish to apologize if what I said earlier offended any of you. I was and still am under considerable pressure of responsibility. I'd like to ask a special favor of one of the media crews who made a video tape of the Admiral's verbal report before he left. I will not and cannot restrict your use of anything you recorded here, and I won't even consider censorship. But my government would greatly appreciate it if, under the circumstances, one of you would permit [illegible] the use of the video tape [illegible] statement. It would be [illegible] Santiago and retaped [illegible] used with full credit [illegible]"

because it's the *only* report that the inspection commission will be able to make as a full commission. It will most certainly lead to refutation of the current charges against the United States in the UN Security Council and it would be of inestimable value to the security of your country and mine."

"To hell with you, Governor!" somebody shouted from the back of the crowd. "If you want our tape, pay for it, just like your government made the United States taxpayer fork over all that equipment to you!"

Bill Jacobs from NBC raised his hand. "Governor, I apologize for the outburst from my media colleague. Small people do petty things. NBC would be proud to have you use our video tape." The tall, handsome newscaster turned to his cameraman who ejected a video tape cassette from his portable recorder and gave it to Jacobs, who in turn handed it to Obregón. "Just give it back when you've transmitted it to Santiago, will you, sir? I've got to transmit it to New York as quickly as you'll let me."

"Thank you, Mister Jacobs." Obregon took the cassette and returned to the interior of the ground station shack. It was only a few minutes before he emerged again and handed the cassette back to the NBC reporter. "Miss Fisher, now it's your turn."

"Frank, please come with me," she asked the shuttle command pilot quietly.

"Sure."

"Joyce, do you want to use our tape, too?" Bill Jacobs wanted to know.

Joyce sighed and replied, "Unless somebody else would like me to use

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theirs to spread around our thanks to those of you who're being so helpful right now."

"You look distraught, Joyce," observed Walter Bishop of CBS.

"I am. Most of you know my father was in the foreign service in Chile and that I grew up in Santiago. The Chileans may have lost two valuable men, and we may have lost ten fine young airmen and a C-5 transport plane . . but I lost a very old and dear friend, Colonel Ríos . . ." Joyce knew that the video cameras were running and she could hear the click-whine-click-whine of 35-millimeter cameras. She didn't particularly care about the loss of hardware, but she cared very much about the people. And if the world knew about it, so much the better.

"With all deference to my colleagues from NBC, please use our video tape in your report to Washington," Bishop offered. "It may help if there're two official records taken by two separate cameras from two different locations."

"Thanks. It will."

When Joyce got through to Alfred M. Dewey and made her report, Dewey almost came apart. "*Two members* of the inspection commission? *The* commander in chief of the Chilean navy? The deputy chief of staff of the Chilean air force? Good Heavens, Miss Fisher, this is an international incident!"

"No, sir, not if we handle it properly. One member of the commission's still alive and well on Pascua," she told him calmly. "We have several video tapes of Montero's verbal announcement made publicly to the press. If you'll make arrangements, I've received permission from CBS to transmit their video tape to you for the use of the State Department. As soon as I make my report to you, the media will probably be filing their stories, and it'll be all over the evening news. That'll give you and NASA—and probably the White House, too—time to put together a news release expressing our deepest regrets to the President and people of Chile as well as to the families of the Air Force people who were lost. And it gives you a perfect excuse to release the Montero verbal report."

"But will it be believed?"

"It can be confirmed by Professor Pérez."

"Very good, that's what we'll do if I can get clearance for it. I'll get this information up to the Secretary and over to the White House," Dewey told her. "You're doing a fine job there, Miss Fisher. Now I've got some additional information for you on the Soviet naval vessels. They've been located by Navy Orion patrol planes passing about 700 miles south of Hawaii on a course toward Pascua and refuelling at sea. The carrier *Kitty Hawk* and the guided missile destroyer *Cochrane* are paralleling their course and keeping them under air surveillance. The Navy is putting together Task Force Sixty-Nine consisting of the guided missile cruiser *Halsey* that will leave San Diego tomorrow to join the *Kitty Hawk* and the *Cochrane*. So when those Soviet ships show up at Pascua, you can be sure the Navy's right behind them."

"Mister Dewey, is there a Marine contingent in that task force?" Joyce wanted to know.

"Marines? Why?"

"The NASA and Air Force people

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[illegible] They're not sure the Chilean military contingent on the [illegible] security against [illegible] or even some sort [illegible] affair.

[illegible] sounds [illegible]

We don't [illegible] We may be getting involved in internal Chilean political affairs. After all, both Admiral Montero and Colonel Ríos were [illegible] with the junta."

Miss Fisher knew Chile and the surrounding area to keep [illegible] internal Chilean political affairs," Dewey told her.

Joyce read between Dewey's [illegible] and knew there was even [illegible] knew the only thing he wanted to do was get Joyce safe and get out of this affair with as little controversy and as few opportunities to make mistakes as he could possibly arrange. He was a career Washington foreign service man [illegible] office from the vagaries and threats of revolutionary demonstrations, [illegible] and today interfaces with [illegible] that were the [illegible]

[illegible]

[illegible]

[

anyone would want to kill any members of the inspection commission. We Chileans have made a great deal of social progress in the past ten years. Yes, I believe the mission of the *Atlantis* was completely civilian and peaceful in nature, and the commission was unanimous in coming to that conclusion."

Over and over again, Joyce: "I'm the diplomatic representative of the Embassy of the United States in Santiago. There's no reason to suspect the incident will change any relationship between our two governments, and I doubt it has anything whatsoever to do with claims made against the United States in the UN Security Council—claims that you know are false because you heard the commission's preliminary report yourself from the late Admiral Montero."

Over and over again, Frank: "I don't know if the wing came off first or if the C-5 blew up first. I wasn't expecting anything to happen, and I was just lucky to be looking at it when it did. There've been troubles with the C-5 throughout its service life; that's common knowledge. But it's basically a very good airplane, it's serving us well, and I wouldn't be afraid to fly it or in it . . . And don't think I'm saying that because I happen to pilot a space shuttle occasionally. The *Atlantis* may be a flying brick, but she's a pussy cat to fly and almost any good airline transport pilot could learn to handle her. I haven't flown the C-5 because I've been a fighter pilot, a test pilot, and a space pilot. But that doesn't mean that I wouldn't fly the C-5 because she might fall apart in the air around me. Are any of you afraid to drive your cars just because somebody else has accidents with the particular make and model you happen to have?"

Finally, Casey in desperation: "Look, gang, you're asking the same questions over and over again, and you've gotten the best answers we have right now. Let's break this up. You've got stories to file to make your afternoon deadlines. I'll be up at the Press Club, and if you really want to talk to any of the NASA or Air Force people, I'll see what can be done. Conference adjourned!"

But another conference was quietly brought to order shortly after supper on the south slopes of Rano Kao volcano atop the cliff of the birdmen, *Tangata-Manu*, only a couple of miles from Hangaroa and completely out of sight of Ororito City. Frank organized it, and it was attended by Lew, Jackie, Hap, Joyce, Red, Colonel Matt Hubbard, and himself.

"What the hell is so damned important and secret that we've gotta come all the way out in the boonies here?" Red wanted to know. "I've gotta keep my eyes on those Chilean contractors. We should have the ramps completed tomorrow."

"This is just between us chickens," Frank explained, looking out over the expanse of the South Pacific Ocean beyond the small islet of Motu Nui. "We're probably going to have a little visit from two Soviet naval vessels in a couple days. They've been spotted by Navy P3's and our surveillance satellites seven hundred miles south of Hawaii and headed this way."

"Obregón knows that," Joyce pointed out. "He doesn't seem to be concerned."

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"Well, maybe he knows something we don't," Red put in.

"I think it's the other way around," Frank said. "Planes from the carrier *Kitty Hawk* are tracking the Soviet ships now, and the Navy's put together Task Force 69 with the *Kitty Hawk*, the *Harvey* and the [illegible]. This ocean around here is getting full of ships pretty soon."

"Well, what the hell are the Soviets doing sending ships down here?"

"Legal ones," Joyce replied to Red. "What they've got a perfect right to do under the diplomatic status and international rules of the sea."

"Well, yeah, they may want to take [illegible]," Jackie added. "We just wanted to know." She smiled. "Maybe we should shoot them down."

"Not very likely," Joyce pointed out. "I wonder if you let the Soviet ships get near the *Atlantis*," he added, looking at Obregón and Jacks [illegible], whose presence on the bridge made the center of attention [illegible] right now."

"Hmm," Jack Clay growled.

"Hey, I think Joyce has a point," Frank said, and then explained. "Look, I have some aboard and show them around with all the media people taking pictures to beat hell. Sure, why not?"

"Yeah. What have we got to hide?" Red said.

"Right. They're playing games with us, and what else are they doing if they're sending two ships more than eight thousand miles from Vladivostok? We'll play games with them, especially since Task Force 69's hot on their heels, and they know that from their own recon satellites." Frank sat back on a rock, clasped his hands around his knees and grinned. "We'll get Obregón to take us out to the *Kharkov* in a boat, and *we'll* pay a social visit to *them* with the United States Navy standing by and the media recording it all with long-focus lenses."

"Neat," Red observed, but it was obvious something was bothering him about it. "So somebody tell me why they're sending two ships eight thousand miles when we know they're doing it and they know we know. And why, when we're sending three of our best ships here alongside them?"

"Cosmetic coverup," Jackie suddenly said.

"Huh?" Red questioned her.

"Diversion," Colonel Matt Hubbard added. "They're great chess players. I agree with Jackie. It may be a move to cover something else."

"What?"

"I don't know," Hubbard admitted. "Got any ideas?"

"No, but that's why I wanted to get us all together without Obregón," Frank told all of them. "Look, we've got our own little problems as Americans if something happens . . . not that I distrust Obregón. I do trust him. But he answers to a different boss than we do. I just want us to be prepared to defend the *Atlantis*, our aircraft, and our people if we have to."

"NASA Nine-Oh-Five will be in here eventually, too," Red reminded them. "It's a bitch of a job, but they're cobbling up a mid-air refuelling system for her. They're going to test it en route to Santiago and here."

"Risky," Jackie said.

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"The whole damn operation's risky, except that some of the people who planned it didn't think so," Red complained.

"Matt, can you liberate some M16 rifles or even some Ingram MAC10 submachine guns for us?" Frank wanted to know.

"I've got MAC10's aboard my C-5's," Hubbard revealed. "Not enough for everybody, but enough to discourage all but the most serious potential hijackers. Let me see what I can do about M16's. I used to run Coors beer from Colorado to some guys at Andrews. I'll collect a few debts . . ."

"I might be able to get some MAC10's from my friends in Santiago," Joyce volunteered.

Frank shook his head. "No, Joyce, that might tip them off that we're suspicious of whatever's cooking. Matt can get weapons out of the Air Police or some of the Army's airborne boys he has to haul around from time to time."

"You're right," she said.

"Do I hear you right, Frank?" Jackie asked. "Are you saying we'll have to shoot our way out of this?"

"No, but don't you think it's a good idea to be ready to do it if we have to? Damned if I know what goes through the twisty minds of the Russians. Who knows what they've got figured out now that we've managed to blow away their claims that this was a military mission?"

"Didn't they expect their claims wouldn't hold water once an inspection commission had a look?" Red asked.

"Maybe they didn't expect the Chileans to react as they did and send their own commission. Maybe they anticipated the UN Security Council would do it instead and that they'd be able to stack the deck a little bit," Joyce pointed out.

"Anybody here not know how to shoot?" Frank asked, looked around the group sitting on the rocks in a semicircle facing the sea. Nobody said a thing. "I figured as much. No one does the sort of things we do without having learned how to use weapons at one time or another . . . including you, Joyce."

"Why, Frank, what ever made you think that nobody ever taught me how to shoot to kill if I had to?" she replied sweetly in a tone that belied the basic strength Frank knew was part of her. "Maybe Alfred M. Dewey doesn't know how, but he hasn't served in countries where people shoot at each other in the streets from time to time. I know how to hit with a MAC10 on full automatic. Will you show me how to use an M16?"

"Shooting and hitting's on my mind, too," Matt Hubbard pointed out. "I don't exactly like the idea of having my airplanes flying around in skies that could be full of Soviet Goblet and Goa ship-launched anti-aircraft guided missiles as well as Yak-36 Forger fighter planes. Maybe I should've scheduled fighter cover after all when you first called me about this operation, Red."

"We'll have it anyway from the *Kitty Hawk*," Red told him.

Jackie exclaimed, "Who ever thought a Space Shuttle contingency landing would result in an eyeball-to-eyeball confrontation with the Soviets?"

"That doesn't bother me as much as the question *why*?" Frank added.

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CHAPTER FOURTEEN

"Well, where's the Soviet Navy?" Red wanted to know.

Although there was room for the basic NASA team in Ororito City, they'd chosen to stay in the Hotel so they could have the privacy of these Hawaiian-style breakfasts.

"They should've been hull-down on the northwest horizon last night at sunset, by my navigational calculations," Lew remarked. "They're not."

"Obviously," Red added.

"Boys, have you heard anything more from your boss at State?" Frank asked.

Lew shook his head.

"That bothers me," Frank admitted. "What's delayed them?"

José Hey, who'd been helping serve the food assisted by another Pascuan, heard this and remarked, "It is very nice, Mr. King."

"Sorry."

José smiled and remarked in the gentle manner of the Pascuans. "It's strange to me that you seek new worlds and still don't know your own. We watch the sea and the sky the way you watch the stars." He motioned out the window toward Hanga Roa Roads. "The ocean is different."

"How?" Lew wondered. "How's it different?"

"The waves on the beach are now [illegible]," José explained. "They are the heartbeat of the sea and tell me that the waves arrive eight [illegible] out of the sky. What [illegible]

Frank looked at the clouds as a pilot [illegible] cirrostratus. Mares tails. They seem to be focused in the northwest. I've got it, José: there's a low pressure area out there."

"There is a big storm—a typhoon—a long distance from us, and it will not come to Pascua. It will go far to the north."

"South Pacific typhoon," Lew put in. "It's delayed them. We'd better see if Houston will squirt us some GOES-West pictures. Matt might want to know where the typhoon is and where it's heading."

Jackie didn't go with them up to the ground station after breakfast. "I don't feel right," she told Frank. "I'm going to see Doc Esteban."

"Yeah, you look a little peaked, Jackie," Frank said.

A short time later, a picture of the South Pacific taken by the western geosynchronous weather satellite 23,400 miles over the equator told them that José Hey's native knowledge of the sea was correct. Typhoon Bernard was 600 miles northwest of Pascua.

"Right across the course of both the Soviet ships and Task Force 69," Lew pointed out.

"I'm glad to know about it," Matt said with obvious relief. "Nothing between us and Santiago but the usual broken to scattered cumulus between three and eight thousand feet. The Air Weather boys were right: that South Pacific high pressure area just sits out here all year and moves a thousand miles north and south according to the seasons. No wonder the weather's been so good."

"And no wonder they're short of water on Pascua," Hap added.

Because of the good weather, things

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had moved right along. The concrete pads for the stiffleg derrick and tag line masts had been poured, and the stiffleg and tag line masts were now set up. A C-5 had brought in the strong-back that was now being fitted over the *Atlantis*. NASA 905 was due to arrive at noon.

Life on Pascua had settled into the daily routine of preparing Mataveri for the arrival of NASA 905 and the eventual mating of the *Atlantis* to the carrier aircraft. The Pascuans soon became accustomed to the huge C-5 transport aircraft that whined in over their heads on final approach to Mataveri. And, because the work became more highly scheduled and the eventual arrival of Soviet and American naval vessels was still just a matter of waiting, boredom set in. This was most evident among the media people, some of whom decided that the big news story was over and went back to Santiago and New York, content to get pooled TV coverage from Pascua.

After the Chilean inspection commission's report and the deaths of two of its members, things became strangely quiet at the UN. The Soviets said nothing. The Chilean report was forwarded to the Security Council, but there'd been no vote on whether or not to accept it. Alfred M. Dewey told Joyce the United States didn't want to force a vote of acceptance in the Security Council because the Soviets would certainly veto it. The State Department was content to let the matter die of inattention, thereby saving face all around.

Joyce's recommendation that the President of the United States announce the award of the Legion of Merit to Admiral Montero and Colonel Ríos was quietly overlooked. But there were exchanges of diplomatic sympathy notes between Washington and Santiago, and the matter of the C-5 accident was left hanging. The Chileans and the U.S. National Transportation Safety Board announced intentions of investigating the incident, but nothing had been done yet.

So the planned arrival of NASA 905 was the first big event in days. The operation would become photogenic again.

Frank, Lew, and Hap went with Matt into the flight scheduling room where they'd spent most of their time helping the MAC officer set up and schedule the many flights of aircraft into and out of Mataveri. It hadn't been an easy task because every drop of fuel for return flights to Santiago had to be brought in for the C-130 Herks or available from KC-10 tankers that had to be scheduled on station between Santiago and Pascua.

Red joined them about nine A.M. in what had become the flight operations room in the radio shack below the tower. "We're all set for Nine-Oh-Five," he told them as he got a cup of coffee and sat down. "Time for coffee anyway. When the caffein level in my blood gets low, I get mean and I'm no longer my sweet, lovable self."

"You should've joined the Navy," Lew pointed out. "The Navy runs on coffee."

"The Air Force would like to," Matt put in, "but we've had to stick to milk and cokes. In general, Air Force coffee's lousy."

"You can say that again," Lew grumbled.

"Tell me, Red, how did you NASA

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types solve the range problem with Nine-Oh-Five?" Frank asked. "Did you put in an in-flight refuelling receptacle from a C-141B or B-52H?"

"Couldn't. When Hank finally came to that conclusion and the Dryden gang was forced to think their way out of it, it became relatively simple," Red explained. He sipped coffee and went on, "Since they didn't need to transfer a lot of fuel in a hurry the way they do with a B-52, they got smart and installed a probe off an old A-7. With the probe-and-drogue system, there's no need for high-pressure fuel piping. Sure, it takes forever and a day to transfer enough fuel, but they're in no hurry as long as they take it aboard faster than the engines burn it off. Boeing installed a series of bladder tanks—the kind they use when they ferry a little Seven-Three-Seven to Europe—on the old passenger decks over the center of gravity, and Hank's got unlimited range now with in-flight refuelling."

"As goes to prove when you've got good engineers on the job and they've got to perform, they come up with an answer," Hap added.

The door to the room opened and Ernesto Obregón walked in, a broad smile on his lean face. "Gentlemen, good morning. I thought you might like to know there're two naval vessels in the territorial waters of Isla de Pascua."

"The Soviet ships?" Frank asked, getting to his feet.

Obregón shook his head and led them outside. He gave Frank a pair of binoculars.

A cruiser and a destroyer were on station about three miles off Hangaroa. From their flagstaffs flew the national colors of Chile.

"Two of our best ships: the cruiser *O'Higgins* and the destroyer *Serrano*," Obregón remarked. "I once served in the *Serrano* . . ."

"Why didn't you tell us they were coming, Ernesto?" Frank asked.

Obregón shrugged. "Did you think the Armada de Chile would ignore both the C-5 incident and the Soviet vessels? After all, Pascua is of strategic importance as well as a sheep station . . ."

That made Frank feel better.

Jackie came in later with Father Francisco. She looked like the world had collapsed on her. "Lew, can I talk to you, please?" she asked the co-pilot.

"Huh? Why, uh, sure," Lew replied, wondering why the island's priest was with Jackie, who wasn't the religious type.

They stepped outside and Jackie said, "Let's walk down the ramp here, Lew. We ought to keep this between us right now . . ."

"Keep what, Jackie?" Lew wanted to know.

"Lew, I suspected it a couple of days ago, and Doctor Esteban says I'm right even though he doesn't have the facilities to make tests. And it ruins everything for me, which is why I went to talk to Father Francisco about it . . ."

"About *what*, Jackie?"

"Neither of you are of my religion, but I often have to handle similar problems, and I will be happy to help you," the Catholic priest remarked.

Lew spun Jackie around by the shoulders. "Jackie, what's going on here?"

"Lew, I'm pregnant." There were tears in her eyes. It was the first time Lew had ever seen Jackie Hart weep.

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Lew didn't say anything for a moment. Then he burst out with, "Aw, come on, you've gotta be kidding! That night of the hula? And since then? You're on the pill."

"I wish I was," Jackie said, choked up, and started to cry. "The flight surgeons wouldn't let me take the pill when I was scheduled on a mission that month. They were worried it'd affect my performance, especially during the time when I'd normally ovulate. I knew it would, too, because I'd noticed my performance in the T-38's would get bad and my reaction times would slip when I was on the pill during that time of the month."

"Well, we can have it taken care of. I'll fly you to Mexico and pay for the whole abortion. Uh, sorry, Father, but that's the way we usually handle these things in America now."

"I know, my son. But is it right?" Father Francisco asked.

"That's not it, Lew. That's not it at all!" she choked out between sobs. "Duke Kellogg's sure to find out. Duke doesn't like the idea of women in the shuttle anyway, and I'll never get the chance to shoot for a pilot's slot now."

"Aw, come on, Jackie. We'll take some leave when we get back to the States, and this'll all be straightened out in a day or so," Lew tried to reassure her. "Duke'll never know. I'll never tell him." He put his arm around her and drew her close. "Calm down. Let's go to the hotel so you can put yourself back together without Frank and the others knowing. We'll get this all straightened out once we get back to Houston."

"No, Lew, if it were that simple, I wouldn't be all busted out of shape like this," Jackie admitted. "I'm not religious."

"I know that, Jackie."

"But I can't do what you suggest, even though you probably think me one of the strongest woman's libbers in NASA," she tried to explain. "How do I explain it when I never thought it would happen to me? You and I created life between us, Lew. Even though it's going to wreck everything I've spent my whole life working for, I can't destroy life I've helped create! And although it was fun and I enjoyed being with you and doing it with you, Lew, I don't think I love you."

"Yeah, you've got a problem, Jackie," Lew mused.

"No, my son, you've *both* got a problem," Father Francisco contradicted him gently.

Lew turned savagely to the priest. "Father, you stay out of this! Jackie may have come to you for help, but I don't need the advice of a man who's never faced the problem himself and has to toe the line to an old-fashioned religion. I *know* what you're going to tell me because I know what your religion has to say about it. So spare me the sermon, confessional, and interpretation of some book that was written two thousand years ago that doesn't have a thing to do with our modern world and tells me Heaven's up in the sky somewhere. Well, it isn't, because I've been there and looked around . . . and it isn't up there at all."

"You're right, Lew Clay. Heaven isn't somewhere in the sky," Father Francisco admitted. "Part of it is in you. But don't try to read my mind. I

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[illegible] ordained in the Church of Rome, but I must deal every day with people who still believe the Makemake legend of their ancestors. Under those circumstances, I've had to adapt my [illegible] to the realities of Rapa [illegible]. That's Jackie's answer to [illegible] the most personal tragedy that I've had to work with. You do not have to [illegible] me. But I *do* have some experience in handling the dilemmas and the kinds of problems that threaten to shatter the lives of people."

Lew sighed. "Sorry, Father. This whole thing's a shock to me."

"I can't say as I'm surprised, son. And the answers and solutions are never easy. And I cannot offer you solutions. They must come from within you."

"You may be right, Father. Just promise me you won't preach to me," Lew requested.

"I won't. The problem is a very serious one. The solutions that work on Rapa Nui may not work in your world. But some part of them might. And we'll never know until we try," Father Francisco said. "I would like to say one thing, however, in defense of the Holy Bible [illegible] and other great holy books of the world, by the way. You will find there examples of every possible human situation, even yours. You will find something there, it may not be the whole answer, but it will certainly be part of the answer. Some may claim that it is the whole and only truth, but one needs to minister to the Pascuans to discover, as I have, that it may be only part of the truth."

He looked at the two of them, strangers in his world of Rapa Nui, yet not strangers. "My first suggestion is that the two of you take a very long walk and talk about this alone. If you feel that you need me, Jackie knows where to find me. But I will not be offended if you do not seek me. You must decide between you what to do with your own lives. *Vaya con Dios*. Or, as some of my Pascuan flock would say, may your *aku* have powerful *mana*. You will both need it." He started to raise his hand in a blessing, then stopped, turned, and walked across the ramp toward Hangaroa.

Lew sighed. "Come on, let's go over in the shade of the *Atlantis*," he suggested to Jackie. And the two of them began to walk over to where the Orbiter sat on its landing gear, the steel strongback now attached to it and the streamlined tail cone covering the three big rocket nozzles. It would be over a week yet before the *Atlantis* would be secured atop NASA 905, and even longer before the flight back to the Cape because of all the checkouts to be conducted by Frank, Lew, Jackie and Hap in conjunction with the crew of NASA 905.

Back in flight operations at the base of the tower, Obregón had left to receive the captains of the two Chilean warships, who were coming ashore later for the calls required by naval protocol. Things had quieted down this morning with no C-5's on the island and only one C-130 Herk standing by for contingencies. Early in the operations, Matt had decided to keep one Herk on Pascua at all times just to provide airlift to Santiago if necessary. The C-5 explosion had made him very leery; he'd been a green MAC pilot during the days of the pullout from Viet Nam, and he knew that even military transport pilots could

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get involved in combat operations.

"Couldn't get Ingram MAC10's for you," Matt said quietly to Frank. "But we've got a bunch of M16 rifles and enough ammunition to supply an army."

"Where'd you put them?" Frank wanted to know.

Hubbard jerked his thumb over his shoulder. "Back there behind the crates some of our gear came in. I brought them in during a very busy time, and none of the Chileans bothered to look at them. And they won't look over there."

"Bet they're all packed in cosmoline," Hap remarked. "I've never seen the government ship anything that wasn't sealed so tight or greased so thoroughly it couldn't survive thirty years under fifty feet of water in the Houston ship channel."

"Nope. These babies are ready to use. Got 'em on consignment from the Air Police armory at Andrews. The major in charge owed me a few favors." Hubbard explained.

"Pascua Tower, Redeemer Zero One Three, Ostra intersection, landing Mataveri," barked the loudspeaker Hubbard had rigged to broadcast the tower communications down into flight operations.

"Redeemer Zero One Three, Pascua Tower, Pascua weather clear, visibility thirty kilometers, temperature two seven Celsius, wind one two zero at five, altimeter one zero zero four, using Runway One-Zero. Cleared visual approach Runway One-Zero. Report the aerodrome in sight."

"Redeemer Zero One Three."

Matt was silent for a moment, then picked up a clip board from the table and looked at the sheaves of paper on it. Then he looked back up at the now-silent loudspeaker. "I didn't think we had any airlift planes scheduled before NASA Nine-Oh-Five. Frank, did you schedule anything this morning?"

"No, and I don't think Lew did, either."

Hap shook his head. "I didn't schedule an airlift plane this morning."

Matt picked up another clipboard and ran his finger down a list of assigned aircraft calls. "I don't think we've got a Redeemer Zero One Three assigned. Nobody wants that call number. There's no Redeemer Zero One Three, and nothing scheduled before NASA Nine-Oh-Five!"

Jumping out of his chair, he began tearing the tops off of crates stacked over in the corner. He pulled out an M16 rifle and tossed it at Frank. "Cram your pockets full of ammo clips from that box on the left, Frank. Then go tell Obregón. Hap, grab this M16 and get up to Ororito City; alert the people up there and have them shag-ass down here to pick up rifles. I'll get my Air Force boys and Red Richardson alerted." He checked the action on an M16 and slipped a clip of ammunition into the receiver. "The Palestinians tried to sneak one in like this at Aswan once. We'll handle this one the same way." He picked up a mike and snapped, "Tower, this is Operations. When Redeemer Zero One Three lands, direct them to taxi to parking on the south ramp." He put down the mike and added, "We'll be ready for them there."

Frank commandeered one of the Air Force pickup trucks parked outside and careened down the narrow dirt road to-

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ward Hangaroa and the military governor's quarters. All the while, he was thinking: *Where's Joyce? My God, I've got to find Joyce so she doesn't get caught in this!*

He found Obregón just leaving his quarters. "Ernesto, red alert! We've got an unknown aircraft trying to sneak in with a non-existent call sign."

The little military governor didn't hesitate a moment. "Come with me," he snapped and went back into his quarters. Frank followed, and Obregón led him to a part of the casern Frank hadn't visited before. The small room was equipped with quite modern and very sophisticated radio equipment.

"I didn't know you had this stuff, Ernesto," Frank said, noting that it was very new single sideband U.S. Navy gear from which nobody'd even bothered to remove the markings or serial numbers.

Obregón didn't waste any time as he turned things on. He remarked, "Frank, I'm certain you haven't told me everything you and your people brought to Pascua, either—for example, that M16 rifle you're carrying. I'm not ill-equipped or unable to defend the island. And there are two marine detachments aboard both the *Carvoca* and the *Serrano*. What arrangements have been made at Mataveri?"

"Hubbard's having the aircraft directed to the south ramp area."

"Good. . . . If the plane follows the instructions of the tower. Do we have enough time for Richardson to block off the entrances to the north ramp with construction equipment?"

"Should have. There's at least twenty minutes before that plane lands, depending on what kind it is."

Obregón shook his head. "Not enough time to get a marine unit ashore. I'll report to our ships and have my garrison up there right away. Find Richardson and have him block those ramp entrances where the *Atlantis* is parked. I'll be there shortly."

But Frank didn't go directly back to Mataveri. He went instead to the Hotel Hangaroa, but Joyce wasn't there. On his way back to Mataveri, he asked himself, *What am I doing, chasing all over this island, trying to find a woman I shouldn't be involved with in the first place? Ellie, forgive me!*

Both Joyce and Richardson were in the satellite ground station. Red was talking to Houston when Frank burst in. "Did either of you get the word?" he asked immediately.

Red looked up. "No, what's going on? I'm talking to Joe Marvin."

"Give me the mike, Red. I'll fill everybody in." Richardson moved to one side, and Frank sat down at the console. "Joe, we got trouble. I think we can handle it okay, but pass the word to Washington." He gave a quick rundown of the situation, then said, "We're ready for them, but we've got to get the hell out of this ground station. I'll talk to you when it's over." He put down the mike without waiting for a reply and told Joyce and Red, "Get over to the operations shack and pick up a rifle. You said you could shoot, so you may have to. Red, do you have time to move equipment to block the entrances to the north ramps?"

"I'll try," Richardson snapped and moved.

Frank turned to Joyce. "I was afraid

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you wouldn't get the word and stumble into this mess. Grab an M16, find Jackie, and get back to the hotel. Shoot if you have to."

"Where are you going to be?" Joyce wanted to know.

"At the *Atlantis*. She's probably the target if this's indeed a raid."

"It probably is," Joyce observed. "And you're going to need all the firepower you can get because you're on the defensive and don't know how many are coming in. This could be only the first planeload, Frank."

"I told you to get a rifle and get back to the hotel," Frank reminded her.

"And I'm telling you it's my job to get the *Atlantis* off Pascua, too. So I'll be over there with the rest of you, and don't try to pull rank on me because you aren't in charge here, Frank! There's no rule that says a diplomat can't shoot. In fact, it's about time we diplomats had the chance to shoot back rather than just cower in a corner. *¡Vámonos! . . . ¡Dése prisa! . . . ¡Pronto!* Just don't stand there, Frank! That plane's getting closer every second, and we haven't got time to argue."

There was hardly time to get everyone in position. Frank found Lew and Jackie sitting in the shade under the *Atlantis*. He and Joyce thrust M16's at them. "We were worried about terrorists? Well, they may be on their way. There's an unknown plane coming in."

Jackie and Lew looked at each other, then both loaded clips into their rifles.

"Never thought I'd have to defend an Orbiter in a good old shoot-out," Lew remarked.

"You never thought a lot of things would happen," Jackie told him.

Frank detected a *double enténdre* in Jackie's tone, but there wasn't time to think about it. "There isn't much cover out here," he pointed out. "We'll have to see where they land and where they commence their attack. If we have to, we'll take cover around the trucks and the Manitowock crane. If they start throwing explosives or shooting rockets, get under a truck. Here come some of Ernesto's boys; they'll back us up."

"Think a bullet'll penetrate the side of the cargo bay, Frank?" Hap asked.

"I don't know. The ceramic HRSI and LRSI might stop some, but I'd guess seven-millimeter stuff would go right through the FRSI coatings."

"I hope nothing hits that Landsat," Hap worried. "That's a real expensive and delicate piece of gear."

"I hope nothing hits *you*. You're more expensive and delicate," Frank pointed out. "And don't hand me anything about having been produced by relatively unskilled labor, either. Okay, here it comes."

There was no mistaking the fat hull and the big high wing with two radial piston engines. It was an old World War II PBY-5 Catalina amphibious flying boat with no visible markings on it. Hundreds of them were still flying in various backwaters of the world, especially in South America, where they could land on rivers, lakes, or even unprepared fields.

"Okay, can't be many aboard," Frank pointed out. "Maybe thirty people at the most. We'll have them outnumbered and outgunned . . . and they don't know we know they're coming."

"Maybe they've taken that into account," Lew observed.

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Obregon's voice boomed out over a loudspeaker near the tower. First in Spanish, then in English, he ordered, "Everyone take cover and hold your fire. Let them take the first action. We have them outnumbered. I repeat: take cover and hold your fire."

"That's going to be hard to do," Lew said. "If and when they start shooting."

"Damn. Red didn't get his equipment in place in time!" Frank swore.

The Catalina was flying light. She'd obviously burned off a lot of fuel. She was down and stopped on the first 500 feet of Runway One Zero.

"Redeemer Zero One Three," boomed the loudspeaker on the tower, "turn right. Repeat, turn right—at the intersection and park on the south ramp."

The pilot of the PBY ignored the order. He turned left into the north ramp where the *Atlantis* was parked.

"Redeemer Zero One Three, this is the military governor of Isla de Pascua," the tower loudspeaker barked again as Obregon tried to make contact with the PBY by radio. "Stop there! ¡*Halte*! Stop your engines. You are under the guns of the naval garrison of Isla de Pascua. Stop your engines and disembark with your hands in the air."

The PBY engines coughed and the propellers came to a halt, the plane sitting not more than 200 yards from the *Atlantis*, pointed directly at the Orbiter.

Somebody opened fire with an assault rifle from the front turret of the old patrol boat.

Frank had heard that sound before. It was a Kalashnikov AK47 assault rifle, made by the millions by the Soviet Union and the Warsaw Pact countries, copied in China, and encountered all over the world in the hands of revolutionaries, guerrillas, and terrorists.

The burst hit the *Atlantis* over Frank's head. Chips of high-temperature ceramic tile material spalled off the *Atlantis* where she'd been hit. Frank and Lew opened fire from behind the two-and-a-half-ton trucks between the PBY and the *Atlantis*, aiming toward that front turret. It'd been a long time since Frank had used an M16; his burst wasn't on target. Neither was Lew's.

Hatches on the aft hull of the PBY popped open, and there came the thud of mortar fire. The PBY rocked backward on her main wheels with the recoil.

"Under the trucks! Take cover! Mortars!" Frank yelled, diving for the safety of the truck and pulling Joyce down with him. He wasn't worried about getting hit until the terrorists got the range; the recoil of the mortars rocking the PBY wouldn't help them get accuracy quickly.

There came the sound of two M16's firing in bursts from above. Frank squirmed around to see Jackie and Hap in the open hatch of the *Atlantis* returning the fire from the PBY.

"How'd they get up there?" Frank growled. "The fools! They're prime targets in that hatch!" He knew why they were there. That Landsat was Hap's baby, and he was protecting it. As for Jackie, the *Atlantis* was something to be defended with her life if necessary. Neither of the two had been under fire before. Neither knew that the place to defend the *Atlantis* best was on the ground.

Two mortar shells landed on the ramp

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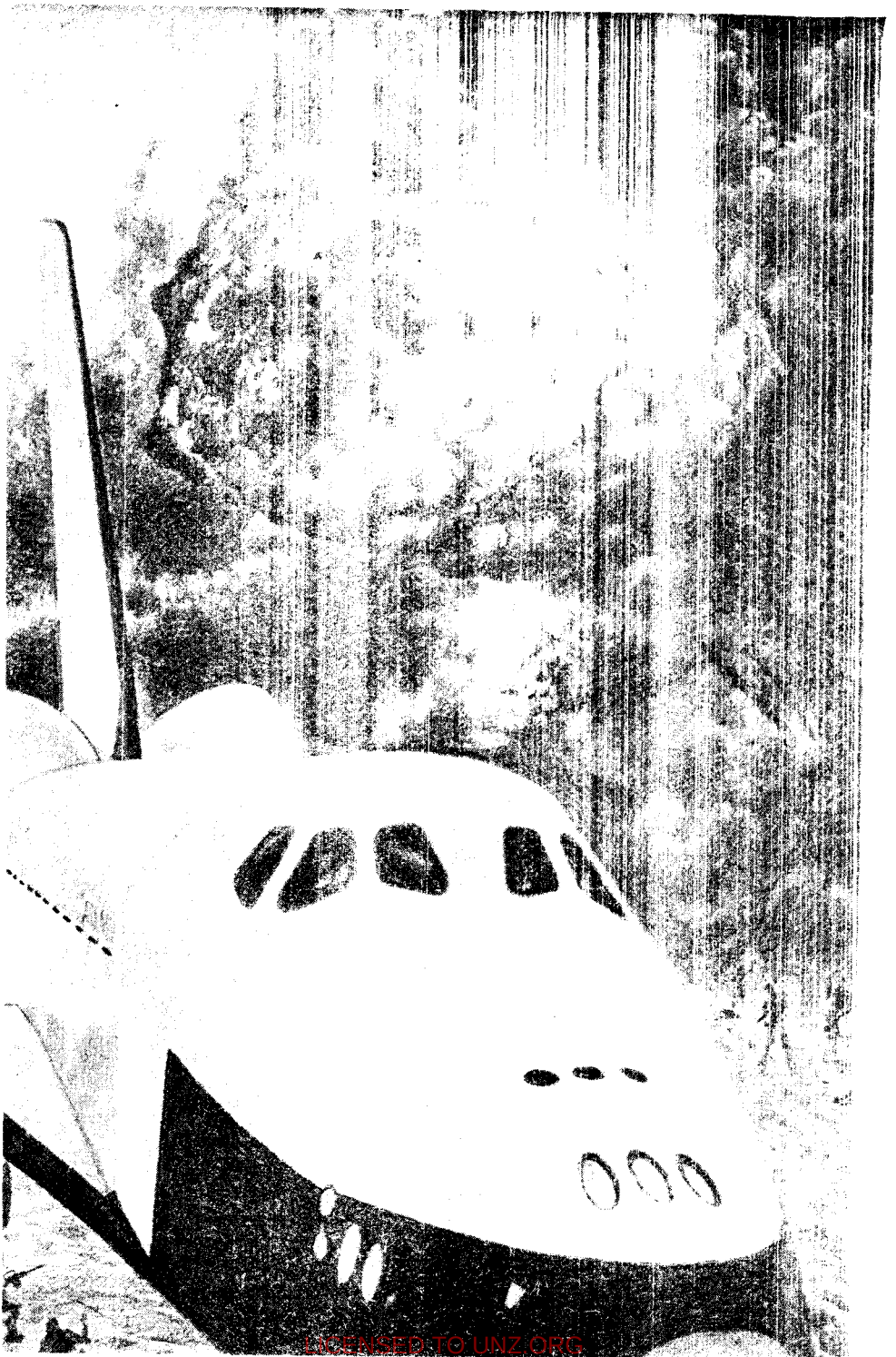

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selves around the *Atlantis*. From the explosions, Frank knew they were up against eight 60-millimeter M2 mortars, standard issue that was made in the United States for export countries and supplied to guerrilla and revolutionary forces worldwide.

Someone inside the PBY lobbed four smoke grenades onto the ramp around the plane. Through the thick enveloping smoke, Frank and Joyce watched as hatches flew open and two dozen armed men poured forth screaming and yelling at the top of their lungs. It was hard to see them through the smoke, but they were all wearing rag-tag unmarked dark green fatigue uniforms with soft hats. They charged toward the *Atlantis*.

There was no need for Obregón to give the order to open fire. A hail of bullets from the Chilean SIG510 automatic rifles and M2 carbines ripped into the smoke, into the PBY, and into the horde of charging men, some of whom dropped to the ramp to provide covering fire for others running full tilt toward the *Atlantis*.

Two more mortar rounds were fired from the PBY's aft blisters. All were direct hits.

Frank's M16 bucked against his shoulder on full auto as he ripped off a clip toward the rushing men. Reloading, he saw Joyce run off semi-auto bursts, carefully picking her targets.

One terrorist almost made it to the truck under which Frank and Joyce were firing. Frank shot his legs off.

Somebody hit the wing tanks of the PBY. The remaining avgas in these tanks went off in a billowing ball of orange flame.

It was obvious that the terrorists hadn't expected or fully planned that their arrival would be greeted by the defensive force that was present. Either the terrorists were counting totally on an element of surprise, or the operation had been poorly planned, Frank decided.

Within a minute, it was all over. The 200 yards of ramp between the wrecked PBY and the *Atlantis* were covered with bodies, some of them writhing, some lying completely still. Five others jumped out of the PBY, but the Chilean naval garrison cut them down almost before they hit the ramp.

Frank turned to Joyce. "You okay?"

"Yes. Scared, but all right."

"Welcome to the club." Frank told her. "I never joined NASA to do this."

"Did you kill anyone?"

"Yeah, that guy right in front of us. You?"

"I don't know. I don't think so."

"You don't need to know, anyway. Come on, let's get out of here. There's Ernesto and Doc Esteban. There may be some wounded. Maybe we can get them to tell us where they came from and who backed this little fracas."

The two of them crawled backwards and emerged from under the truck. Obregón was walking around the ramp, looking over the dead and dying terrorists. Part of his garrison was with him, watchful lest there be some attempt of any wounded terrorist to shoot.

The military governor stood over one moaning man, looked at him, and muttered, "*Mi sentido pésame, Luis.*" He pulled his Colt .45 from its holster and shot the wounded man in the head.

"My God, Ernesto must have known him!" Joyce breathed, turning her head.

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Doctor Victor Esteban saw this and strode up to Obregón, arguing loudly in rapid Spanish.

"He's telling Obregón that it's not right to shoot wounded men," Joyce translated quickly for Frank.

Neither of them believed what they saw Captain Ernesto Obregón do next.

"And it's not right to blow up airplanes with people in them," Obregón said levelly in English. He pointed his Colt .45 automatic pistol and deliberately shot Doctor Esteban through the chest.

CHAPTER FIFTEEN

Before Frank and Joyce could react to the scene they'd just witnessed, Hap's voice called out from the open hatch of the *Atlantis* behind them. "Frank, give me a hand here. Jackie's been hit!"

"Ohmigawd," Frank breathed, "and Ernesto just shot the only doctor on the island."

It was Lew who reacted, dropping his rifle and sprinting back to where Jackie's non-regulation rope ladder swung from the open hatch. He clambered up and disappeared.

The welfare of his ship and crew came before anything else in Frank's mind at the moment, Obregón and Esteban notwithstanding. He turned and followed Lew.

The black-and-white tiled sides of the *Atlantis* had taken a few hits from the AK47 assault rifles. The impact had shattered some tiles, cracked others, and penetrated more of them than Frank liked. It would take some work to put the *Atlantis* back into shape for orbital flight again.

Jackie Hart was unconscious on the floor of the mid deck. She'd been hit on the left side of the lower abdomen.

Hap and Lew were both over her. "The slug went clean through her," Hap remarked. "I don't know if we can stop the bleeding or not."

"Dammit, Frank, get *some* kind of help for her," Lew growled. "We can't lose her. I can't lose her. Get some medical help here quick!"

Frank had never seen his co-pilot like this before. He'd sensed there was something between Lew and Jackie, but they'd never confided in him. Now, Lew didn't need to say anything. Frank knew exactly what had been going on.

He scrambled back down the rope ladder to the ramp and walked purposefully over to where Obregón was still looking at dead and dying terrorists, pistol in hand.

"Ernesto," Frank told him, "Jackie's been hit. She's bleeding to death up there in the *Atlantis*. And you've just shot the only doctor on the island. So help me God, if Jackie dies, you're going to have to answer to *me* for it! Where can we get medical help for her now?"

Obregón snapped his head around to look at Frank. "Jackie? Hit?" he asked.

"That's what I said, Ernesto. And why did you shoot the island's only doctor in cold blood here?"

"Because he was responsible for the C-5 destruction, the death of my admiral and Colonel Ríos, and indirectly for all these dead and dying men," Obregón tried to explain, his tone suddenly sad. "Don't ask me how I know, but I did what had to be done. Esteban was the only person who went aboard

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every airplane that landed here in order to conduct a public health inspection. I know that he could and did place a bomb aboard the C-5 Galaxy."

"What makes you so sure of that?" Frank wanted to know.

"Because I know Doctor Victor Esteban was an agent of the Soviet KGB." He looked up at a sudden new sound and Frank followed his gaze.

A Bell 206 helicopter with Chilean insignia and "CA-02 O'Higgins—Armada de Chile" on its side was settling to the ramp. The door slid open and men wearing white armbands with red crosses and carrying equipment poured out onto the Mataveri ramp.

Obregon holstered his pistol and put his hand on Frank's shoulder. "Don't worry, my friend. We'll have Jackie Hart in the sick bay aboard the *O'Higgins* in less than ten minutes. After all, Chile is not as backward and primitive as some of your media people think."

The Chilean naval paramedics went to work quickly once Obregon gave them instructions. There had been two members of the Pascua garrison who'd sustained wounds. But Jackie was the worst casualty.

Obregon shook his head as they lowered Jackie in a stretcher to the ramp from the *Atlantis*. "How did she manage to get hit?" he wondered half aloud.

Frank sighed. "She's a seasoned fighter. But not with a gun. She was up there fighting for what she hoped would be her home some day," he told the military governor.

As she was being taken across the ramp to the chopper, Jackie regained consciousness enough to recognize Lew alongside her. "You okay, Lew?" she asked him clearly.

"I'm okay, Jackie. And you'll be okay, too. I'm going with you to make sure."

"I knew you would, honey. I knew you would all along." She grasped his hand and held it in a surprisingly strong grip.

"She'll make it," Lew remarked to Frank as they passed him.

"Sure, she'll make it," Frank told his co-pilot. "She's tough . . . where it counts." He was going to have a lot to say about Jackie Hart to that clown, Duke Kellogg, when they got back to Houston. One whole hell of a lot, as a matter of fact.

A new sound intruded upon them: A Boeing 747 with red, white and blue stripes along its side and "NASA 905" on its rudder touched down on the runway next to the ramp, the 16 tires of its main landing gear leaving a cloud of white smoke as they screeched on the asphalt and her four fanjet engines roaring into the thrust reversers.

Jackie heard it. There was a smile on her face as she was put aboard the Chilean helicopter, Lew at her side.

Red appeared, looked distastefully at the wrecked PBY-5 on the ramp, handed his M16 to Frank, and said, "Well, now that the fireworks are over and N'ne-Oh-Five's here, I can get on with my job. And I guess you'll want me to get this wreck off the ramp, too, won't you?"

"Leave it where it is," Obregón told him. "I've got to go through it and see if there're any papers or other documents aboard that'll confirm what I know about it and where it came from."

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"Where *did* it come from, Ernesto?" Frank wanted to know.

"A place called Lake Rogagua, but the Bolivian government didn't know about it. It refuelled at sea off Punta Coles, Peru, last night from a submarine that flew no colors but came from another Santiago a long way around Cape Horn. Richardson, I don't know if I'll find anything, but I've got to look. I'll let you know when to move it. Shouldn't be more than twenty-four hours."

"Okay, Governor, I'll work around it," Red told him, "somehow. I don't like it this game of international intrigue you people play. It almost caused me to get my ass shot off. When are you going to quit playing around and get to work on some serious problems? You know, maybe I ought to get involved myself. Maybe I could help spank some of these big playful boys with their guns and ships and planes and thermonuclear devices. Maybe I could. Maybe I will." And he walked off.

"I hope he does," Obregón added, looking at the retreating back of the NASA engineering manager. "There're plenty of people like Red Richardson who love to work with the problems of things. We could use more people who like to work with the really big problems of people."

"Ernesto, I think you're something more than just the military governor of Pascua. You seem to know a lot about things that you shouldn't know anything about at all," Frank observed. "I think we need to go somewhere and have a little private talk, Ernesto."

Obregón shook his head. "And I don't think so at all, Frank. Your job's command pilot of the *Atlantis*, and your responsibility's to get it back to the United States. My job's to protect it and all of you while you're here. How I do my job is, frankly, my concern. But I'll tell you this much: I didn't expect this to come when it did, or I'd have been better prepared. As it was, they rushed me. Otherwise, Jackie would never have been hurt. So I must apologize for not doing my job very well in that respect. But the Armada de Chile will take care of her. And she'll be transferred to the *Kitty Hawk* when Task Force 69 arrives tomorrow . . . escorting the two Soviet vessels, by the way."

"How'd you know? Did Joyce tell you about Task Force 69?"

Captain Ernesto Obregón chuckled. "Colonel King," he said with deliberate emphasis on Frank's military title, "all military and naval organizations must have some sort of intelligence operation in order to function. Correct? The world today would be a much different place if, say, Admiral Kimmel had received that warning telegram before the attack on Pearl Harbor, or if Admiral Nagumo had known there was no air defense left on Oahu after his second wave completed their attack."

"Nice try, Ernesto, but it didn't answer my question."

"Let's just say that the intelligence activities of the Armada de Chile are certainly not unsophisticated. And we have some help. We appreciate the fact that the United States is willing to send naval elements to assist us, but we will protect ourselves and our guests. Joyce, Frank, Hap, shall we go have some lunch?"

"Hold it, Governor." Casey walked up, followed by a contingent of report-

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ers and TV cameramen. "The media people have asked me to get you all together, now that the fireworks are over."

Some of the media crew were flushed, while others were still getting color back. It was obvious some of them had been scared. For the real pros, it was the chance of a lifetime to get that Pulitzer-winning coverage. But not all were that good, not all were used to witnessing raw violence, and they didn't look well.

As a matter of fact, Frank thought, Casey didn't look too good himself.

Obregón glanced at Frank, then at Hap, then at Joyce. It was Joyce who replied. "Why not? These people have to do their jobs, too."

"Did you get good coverage, Casey?" Frank asked.

"Great stuff. Listen, the way the crew stood up there and defended the *Atlantis* was heroic. Some of the media gang now figure if a Space Shuttle Orbiter is so important that somebody'd try to blow it up, there must be something more to it than most people in the States think. We've got a bunch of real enthusiastic converts now. This whole Pascua affair has helped NASA immensely."

"A lot of it's been due to the way you've handled the media people, Casey," Joyce told him.

"Maybe. I've just tried to keep them happy, that's all. So let's get this show on the road. Can we hold the get-together right out here on the ramp where it happened?"

"I'll let's move off a bit so that all these bodies on the ramp don't show," Herb Haynes remarked. "Sure, it was exciting but let's not be macabre about reporting it."

"Why not?" It was Marty Soloman again. "A little blood and gore goes over great. TV audiences love it. Just look at the series with the top Neilsen ratings."

"And it makes some of us sick to our stomachs, Marty baby." Surprisingly, this came from Alice Arnold. "Go shoot all the gore you want, Marty. You're right, Herb: let's move over a little bit, even though I don't file a video report."

"Speaking of sick, are you all right, Casey?" Herb asked.

"Me? Sure. Little indigestion. Gas pain up high here. Doctor once said something about a hiatic hernia, whatever that is. I get it every once in awhile," Casey remarked, thumping his chest with his fist. "Okay, Governor, how about you along with Frank and Joyce. Where's Professor Pérez?"

"I ordered him to remain in my quarters at the casern. No sense in risking Chile's top astronautics expert," Obregón explained.

"Okay, troops, I'll arrange for you to get with Pérez later," Casey told his media following. "Go ahead, gang, it's all yours."

Somehow, Frank managed to get through yet another press conference without blowing his cool. It was very difficult this time. It had been a very difficult morning.

The rest of the day wasn't any better, although it helped to get away from Mataveri and the reminders of what had taken place there. The captains of the *O'Higgins* and the *Serrano* came ashore by helicopter later in the afternoon, and

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Frank found himself accepting an invitation to dine aboard the *O'Higgins* that evening with Joyce, Hap, and Obregón.

"I'd like to apologize, gentlemen, but we didn't come to Pascua dressed for formal occasions. I trust that our flight coveralls will be acceptable," Frank remarked to them. The captain of the *O'Higgins* acquiesced because he'd never entertained astronauts or a diplomatic representative of the United States aboard his ship. They were flown to the heavy cruiser in the Bell helicopter, and they saw Lew shortly after being piped aboard.

"She's still in surgery," Lew explained. "They've already told me they can't save her left ovary; the bullet went right through it. They may be able to save her uterus, but they couldn't save the embryo."

Frank didn't say anything, but he'd guessed right earlier.

"She's going to make it, isn't she?" Joyce wanted to know.

"She'd better. I told her so," Lew remarked in a quiet voice, quite unlike him, "because I suddenly found out that I care very much whether she makes it or not. I never felt that way about any woman before. Do you know what I mean?"

"Yeah, I know what you mean, Lew," Frank told him, suddenly aware again of a very real problem in his own life.

"Can you stick around until she comes out of surgery?" Lew pleaded. "Jackie wants Joyce as her maid of honor, and I'd like to have you two share the honor of best men. The captain of the *O'Higgins* said he's got the authority to perform the ceremony, but we want Father Francisco to do it, if he'll officiate over a non-Catholic wedding. If not, I'll ask Obregón."

Later that evening, after a very fine meal with the three captains of the Armada de Chile, they went back down to the sick bay. Jackie made it; Lew had worried, but Frank never had any doubts.

It was a very simple ceremony, and Father Francisco did fly out to the *O'Higgins* to officiate.

Frank felt better the next morning. But the usual "how-goes-it" breakfast found the conversation centered around the actual job of recovering the *Atlantis*, a task that now involved several days of careful preparations prior to lifting the *Atlantis* into the air and towing NASA 905 under it. Red wasn't taking chances. "I'll check everything twice, and then do it again," he told them. "I've come this far, and damned if I want to drop the *Atlantis* now."

They were on the ramp at Mataveri checking the strongback attachments, the stiffleg derrick lines, the Manotowock crane, the tag lines and masts, and the attachment points when the big show took place.

Frank happened to be on the wing of the *Atlantis* and looked out to sea. There were five ships on the northwest horizon. "I believe the call is 'Sail ho!' But I don't think it's applicable in this case," he yelled down to Red. "Two groups . . . A carrier, a cruiser, and a frigate, and two other ships I don't recognize to the west of them."

"Pascua tower, Soviet Navy One, flight of four, ten kilometers northwest, request permission for low pass." There was a slight Slavic accent to the radio

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call broadcast by the loudspeaker on the Mataveri tower, but Frank thought the Soviet pilot had been trained very well in aviation English.

"Soviet Navy One, Pascua tower, low pass approved."

"Ah, Pascua tower," came another voice with a slow Tennessee drawl that couldn't be mistaken for anything but an American fighter pilot, "United States Navy Hawk Alpha, flight of eleven following Soviet Navy One. Request permission to follow their low pass . . . *and we're right on your tail, Ivan, all the way!*"

"Hey, somebody get Casey on the ball!" Frank yelled. "Get the media out for this. It's got to be good with those Navy jocks tailing the Russkies!"

Casey was on the ball. Some of the media cameramen missed it because they weren't set up, although Casey'd told them the Soviet and American naval vessels would be arriving at Pascua that day.

In less than two minutes, the ground at Mataveri shook as a flight of four Yak-36 Forger STOL Soviet naval fighters came barrelling down the Mataveri airstrip not more than 50 feet off the runway. At the north end, the vertical takeoff fighters suddenly seemed to change course and go straight up as their pilots changed the thrust vectors of the swivelling jet nozzles.

But right behind them were three F-14 Tomcats in the "missing man" formation: the slot position in the formation was vacant in honor of Colonel Amaldo Carlos Ríos of the Fuerza Aerea Chile and the ten Americans of the United States Air Force who'd lost their lives in the C-5. Frank, who'd gotten back on the ground and joined Casey and the media people to help provide background, hardly had time to explain the significance of this before the second flight of Navy planes roared over, four F-18 Hornets that pulled up at the north end of the runway and climbed vertically right past the Soviet formation. The third and last flight of four, AV-8B SkyHarriers, thundered over Mataveri, then came to a dead standstill in the air, maintaining formation at a hundred feet, their swivelling jet nozzles pointed down. The VSTOL attack planes transitioned to forward flight again and climbed up to join the rest of the Navy formation flying alongside the Soviet YAK-36 Forgers.

"Pretty show," Frank remarked to the TV crews that were taping the peaceful aerial confrontation. He hoped it would remain peaceful because the *Atlantis* was certainly a sitting duck, to say nothing of NASA 905. "This is probably the first time Soviet and American naval aircraft have been over the same island at the same time. It's interesting the Soviets are keeping a respectful distance. They're obviously doing their best to avoid any maneuvers to provide a comparison of performance between their Yak-36's and the planes from the *Kitty Hawk*."

"Why do you think the Soviet ships came all the way to Easter Island?" Herb Haynes asked.

Frank shrugged, not really wanting to tell what he thought might be the truth. Joyce had probably been right in her assessment. "Maybe they just wanted to get a good close look at the *Atlantis*," he told them.

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He noticed that Casey had suddenly sat down on the ramp. "Casey, you all right?" he wanted to know.

"Yeah, I think so. Haven't gotten much sleep lately. Lot going on. Stomach's acting up again. Lots of gas pains." The NASA Public Affairs man, upon whose shoulders had rested so much of the world's view of the recovery of the *Atlantis* and the activities that surrounded it, looked very pale. He put his hand over his chest. "Hell of a gas pain . . . way up high this time . . .And my arms feel tingling."

Both Frank and Hap were at his side immediately. "Casey, lie down flat on your back. Lie down!" Hap snapped at him. "Those probably aren't gas pains. You may be having a heart attack."

"Somebody get me a blanket," Frank called to no one in particular. "Red, there's one in the *Atlantis* if you can't scratch one up in a hurry. And get it in a hurry, please."

Casey was indeed having a heart attack there on the ramp at Mataveri. In fact, his heart stopped.

Hap began CPR immediately. "Anybody else know how to do this to spell me?" he called out. It turned out that Alice Arnold did.

Frank did the best thing he could for Casey right then. He ran to the tower, climbed the stairs two at a time, and burst in on the Chilean tower operator. Almost completely out of breath, he said, "Call those American planes. Get in touch with the *Kitty Hawk* right now. We've got a man dying on the ramp!"

The young ensign froze, then handed the mike to Frank.

Ten minutes later, a Navy Sea Hawk chopper from the *Kitty Hawk* set down on the ramp with a paramedic team. They got Casey to the *Kitty Hawk* alive, but they had to defibrillate him twice enroute. Hap went with him, continuing to spell Arnold and the Navy paramedics at CPR.

When it was over and the skies over Rapa Nui were empty again, Frank stood on the ramp at Mataveri and looked up at the *Atlantis*. "Are you worth it? Are you really worth it?" he said to the *Atlantis*.

He knew the answer. But he had to ask the question.

It's always been worth it, something told him in the back of his mind. *Did anybody ever tell you that a frontier never claimed any lives? Did anybody ever tell you that being a pioneer means discovering new and more horrible ways to die? You want to sail a new ocean? How can you if you won't risk losing sight of the shore?*

"Red, I'm taking the rest of the day off. Just don't drop the *Atlantis*, okay?" he told the red-headed mission manager.

"I won't drop her. Where you going, Frank?" Red wanted to know. "Don't tell me this operation's got to you, too."

"You're damned right it has. I'm going for a walk. If I'm not back for dinner, come looking for me with a bottle of vodka. No, make that Scotch, and we'll both get stoned. I've got to think . . ."

Rapa Nui wasn't very large—only 11 miles long and 15 miles wide at its greatest extent. It'd be hard to get lost on it. But Frank didn't wander. Something drew him back to those seven huge stone statues, the *moai* on their pedestal

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[illegible] the western sea where five ships lay at anchor offshore.

[illegible] he saw a small figure standing motionlessly at the base of the *moai*. His first impulse was to turn and walk past and to avoid the person. But he saw it was José Hey, who looked up and saw him, then without gesture turned to look back at the sea again.

Frank didn't know what made him sit down beside José Hey and look quietly at the ocean below them, the seven stone shapes gazing out in the same direction.

Finally Frank who spoke. "You come here often, José?"

"Yes, Miti King."

"Why do you keep calling me 'Miti'? Is it some sort of Pascuan title?"

"It is the Pascuan way of saying 'Senor Miti King.'"

"Why do you come here? Is there something special about this place?"

"Yes. No. Perhaps. Those of us who are left don't ever talk. But it must have been a magic place to my ancestors because it still is. Why do I come? To watch the sea and the sky. To learn from them. To learn from the grasses. To learn from the stones. To learn from the *moai* and the gods."

"If the *moai* are responsible for the part of the world they face, are these seven responsible for those ships out there and the people on them?"

José Hey nodded. There was a long moment before he replied. "Jackie Hart and Casey Laskewitz will be all right, Miti King. These *moai* will watch and guard them. And your people have great *mana*. Jackie and Casey both have great *akuaku* with much *mana*."

"I wish I understood exactly what you're saying."

"You do. You are really a very great and powerful *ariki*. You may even be *Makemake*, except Father Francisco says it can't be true."

"José, I don't know your language. I don't know if you're calling me a saint or a sinner," Frank admitted.

"I do not understand your great ship *Athanis*, and you do not understand that you are *ariki* with powerful *mana*." José Hey was silent again for a long minute, then went on, "*Mana* is great power and great magic, and an *ariki* like yourself is a person with very high position and *mana*."

"One man's *mana* is another man's technology," Frank muttered.

"But, Miti King, *mana* is more than your guns and weapons. True *mana* is the magic used by an *ariki* for the good of the people. And you have great *mana*."

Frank understood now. "José, *mana* isn't good or bad; it's the way *mana* is used that counts."

"That is what I said."

Hmmmm. Yes, you did. My mistake. And we've made many mistakes here with our *mana*. It may not be true *mana* the way you just defined it."

"But it really is *mana*. Do you know what your *mana* has already done for us on Pascua?"

"Created problems for you."

José Hey shook his head. "Rapa Nui has seen many people come. Some took Pascuans as slaves. Some imprisoned and killed us here. And some brought us great *mana* that we've remembered and cherished. But the world is changing, Miti King, because we have been brought only great *mana* since the days

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of my grandather. The Chileans brought the beginning of the end of isolation for this island that was once at the center of the world. Now you have brought us even more *mana*, and we are again truly at the center of the world."

Frank was having trouble following the strange reasoning patterns of this man from an ancient culture. "Tell me what you think I've brought you, José."

The little Pascuan began a chanting song:

"O Hotu Matu'a i-unga-mai-ai
Ia Mau Maka, i toona tuura
Ka-kimi te maara mo te arik
Mo te ariki, mo toma."

"What are you singing about?" Frank asked.

"A very old legend that is your story, Miti King," José Hey told him. "I cannot translate it exactly, but it means, 'The god Hotu Mata'a sent here/his servant Hau Maka/to search for a landing place/for the King to land.' And you did, Miti King. Not you alone, but also those who came after you once you discovered Rapa Nui as your landing place. You brought the people who brought more *mana*. Red Richardson has brought us the satellite ground station and television receivers. Now the rest of the world comes to us and we see it. *Mana*."

"I didn't know he'd done that," Frank admitted.

"You have been busy with other things. Now, for the first time, Pascuans are no longer isolated. And Casey Laskewitz has brought people who have made Rapa Nui again *te Pito o te Henua*."

"José, I'm afraid the things we brought you that you think are great *mana* right now may destroy what you have here," Frank remarked. "We didn't intend to change your home."

"What else is there but change? Rapa Nui changes every day. It may not look like it changes, but it does. It has always changed with new people and new *mana*. We are not afraid of change on Rapa Nui, Miti King."

He rose to his feet. "Change is part of *mana* just as change is part of each day. Even the sunset changes and is different. Thank you for your *mana* and those who brought more of it after you, Miti King. All change does not destroy, and this change will not destroy us. We are stronger than that. One must be strong to live at the center of the world.

"I must return to the hotel. *Ia orana korua!*" And he was gone, leaving Frank to try to puzzle out exactly what he'd heard.

He didn't think he was at the center of the world but at the cusp between two worlds.

Well, the Pascuans would have to handle it the best they could. If José Hey was right, they'd make it. They'd grow. They'd survive. They'd perhaps even prosper now that they were no longer isolated. How long could the military governor of Isla de Pascua impose the sort of restrictions required by the old regulations? Not very long, once the Pascuans discovered what the rest of the world was like.

Had he helped create a social time bomb on Pascua? He doubted it. It was no more a social time bomb than the rest of the world whose isolation had been ended by the satellites of space. It was no more of an exclusive cultural problem than the whole world would be

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once space industry and extraterrestrial materials ended want . . . and once power satellites ended localized shortages of energy and permitted people to build their societies.

Frank knew now he hadn't caused the change that was happening on Rapa Nui. He hadn't even caused the change that was enveloping the world. He was just part of making it happen. It had to happen, he decided, because without change there'd never be growth and without growth there'd be decay and a return to a worldwide Rapa Nui of human isolation and want.

He shook his head. "But the price . . . the price . . ."

"What price?"

He looked up as a shadow fell over him.

"How'd you find me here, Joyce?" Frank asked.

"What makes you think I was looking for you?" she replied, sitting down beside him, asking as she did so, "May I?"

"You already have."

"Rhetorical, polite social question," she pointed out, "since I already knew the answer."

"I wish I knew some answers."

"First things first. You were saying something about price. Care to elaborate?"

"Maybe . . . Maybe talking about it will help me get it straight in my mind. I was thinking aloud about the price of change . . . in human effort, in human lives."

"TANSTAAFL," Joyce put in.

"There ain't no such thing as a free lunch. So?"

"So it applies to change, too. Trouble with you hot fighter pilots, you're so interested in where you're going that you never bother to watch your tail. You don't think about where you've been or what got you where you are." She tucked her skirt under her and smoothed it across her knees. She was wearing a skirt today, the first time Frank had seen her in true feminine attire, in something other than slacks or a pants suit. She looked good in a skirt, Frank thought. Her legs looked better in a skirt than even without anything at all. She went on, "Who ever said change was free? Or even cheap? Change any system, and it costs you something. Change? That's energy flow, Frank. And without energy flow, without entropy, there's nothing. And nothing in the future, either. No change, no world, no universe. And it costs in terms of human effort and human lives . . . or even universal life force, if you want me to go mystical on you."

"You're mystical enough as it is," he told her. "Let's get off this approach before we dive into our belly buttons contemplating Nirvana."

Joyce smiled. "That's one thing I like about you, Frank: you're so lyrical."

"There you go again! Look, change isn't my big problem right now. A problem, yes, and it worries me. But not my big problem. You, my dear, are my big problem," he tried to explain.

"Oh? Why? Because we've loved one another? And because we love one another now?"

"Put it that way, yes. I've already promised someone else I'd love, honor and cherish her."

"And it bothers you?"

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"Damned right. All the way around."

Joyce sighed. "We were talking just now about change and growth. Do you *know it's happening to you, too?*"

Frank nodded. "I'm not sure I like it, either."

"Yes, it would be easier if we could remain children all our lives, wouldn't it?"

"Huh? No. Joyce, let me tell you something: If I had to go through childhood again, I wouldn't. Being a kid was the toughest time of my life, even tougher than now. Being a child was being a second-class citizen and having to put up with being told I might be able to do it myself—fly, make love, whatever—when I grew up. Well, I grew up."

"And it was nice when you did and everything settled down and stabilized on an even keel without any worries or problems, right?"

"Uh . . . No. Dammit, Joyce, it's been interesting only when things were changing."

She smiled at him. "Okay, Frank, I'll stop now. I've managed to lead you down the garden path and around the complete circle. At least I've gotten you to admit to yourself that you've changed, and that maybe I've been part of that change."

"But what am I going to do about Ellie now?"

"You've got lots of love you haven't even used yet. Go back and love her, Frank. I think you'll find you love her even more now."

Frank was taken totally aback at this statement. "You mean you're just turning me loose, just like that?" He snapped his fingers. "Wham, bam, thank you, man?"

"Oh, no, Frank! I never had any claim on you. Never! I loved you, I love you now, I'll love you again, and I'll love you for a long time. But I don't own you or any part of you. I only cherish you. Can you understand?"

Frank looked out at the sea, confused. "I'm not sure. I've never run into this before. It's a whole new situation. You're like . . . this is like . . . Dammit, Joyce, it's like, uh, growing up!"

She reached over and gently caressed his cheek. "Hello, Frank. Welcome to the world."

He caught her dark eyes, then looked up at the seven huge *moai* towering over them. "José Hey just told me we're already at the center of the world. With people like you around, Joyce, it's worth living in it."

Frank looked at Joyce, then at the seven *moai,* then back at Joyce. The *moai* weren't the gods and goddesses. But Joyce was the human embodiment of a goddess: the Earth goddess—lover of all, guardian of peace and tranquility, bountiful creator, maker of joyful magic.

A long time later, he looked at the *moai* again and spoke to them, "You're gods and supposed to look out on that part of the world for which you're responsible, huh? But you're not responsible for us any longer. Some of us can make better *mana* magic now. We'll get along without you. We'll eventually give people a world in better shape than it was given to us. In the meantime, we'll take what we've learned is good . . . and we'll take it to the stars . . . but we won't forget our childhood."

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"NASA Nine-Zero-Five, Pascua Tower. You're cleared for takeoff, left turn out. *Adiós, amigos. Buena suerte y vuelva otra vez.*"

The Mataveri runway stretched almost two miles in front of the windshield of NASA 905. "*Gracias, señor. Adios!*" Hank Hoffman put away the check list and nodded at his co-pilot, Jake Stanley, then turned to where Frank was sitting in the observer's jump seat behind him. "Ready?"

"I was sweating less when I landed the *Atlantis* here than I am now," Frank admitted. "*Vamonos.*"

"Okay, let's see if the world's largest biplane flies again. Takeoff power!"

The runway began to move.

"Ah, Houston, brake release. Nine-Oh-Five's rolling," Hank reported via the S-band satellite link.

"Nine-Oh-Five, Houston. Roger," came Joe Marvin's quiet reply.

Frank found himself back in a world of instant communication again. He was separated from Rapa Nui now, and the island seemed an unreal place that was merely a scene in the windshield of the 747 with the *Atlantis* on its back.

"Rotation," Jake Stanley called.

The nose came up, and the runway and Rapa Nui vanished from sight as sky took its place.

The *Atlantis* was airborne again.

To Joyce, Red, and Ernesto Obregón, watching from the ramp, it was an incredible and beautiful sight.

"Incredible that anything that big can fly," Ernesto Obregón remarked.

"Beautiful," Joyce added. "Just beautiful."

"Yeah," Red put in. "We got her off . . . two days ahead of schedule."

As the complex of landing gear struts and wheels retracted into the belly of NASA 905, she was joined by four F-14 Tomcats from the *Kitty Hawk* still on station with the *Cochrane*. The Navy was taking no chances, although the Soviet ships had left days before on the remainder of what the Soviet captain called a "world-circling good-will tour."

Matt Hubbard stepped out of flight operations. "Ready to go, Joyce? Wheels up in fifteen minutes. We're following Nine-Oh-Five into Santiago."

Joyce turned to Red Richardson. "When will you be leaving, Red?"

"Couple more days. Stiffleg's down and stowed in your C-5. I'll get the trucks and the Manitowock crane out in another C-5 later today. Then I've got to spend a few days cleaning up," Red told her. "Governor, you're sure you want us to leave the ramps intact? We'll plow them up like we agreed if you want."

"Leave them, Red, we may need them if a shuttle has to land here again," the military governor explained.

"Yeah, next time we'll know what to do because it'll be in the procedures manual." Red had a moment of hesitation. He took Joyce's hand, started to raise it to his lips to kiss it as he'd seen Obregón do, had second thoughts, paused while he debated whether or not to kiss her goodbye, and finally compromised by holding her hand in both of his. "Joyce, thanks. I couldn't have done it without you. You . . . you're one hell of a woman. Come see me if you ever get to Houston."

"Come see me when you get to

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Washington," Joyce told him.

He held her hand a moment longer, then walked off across the ramp.

She looked up at Ernesto Obregón and told him in Spanish, "Don't say goodbye, Ernesto. I'll see you again in Washington or New York. You will not be on Isla de Pascua forever. You're a very good man, and Chile needs you elsewhere."

"Perhaps," he replied. "Who can tell?" He took her hand and started to raise it to his lips.

She stopped him and added quietly, "I *know* you will, Ernesto. Shall I give your best wishes to the people in Langley, Virginia?"

"You knew?"

"Not at first, but you gave yourself away when you shot Doctor Esteban. I knew there was a CIA contact on Pascua; I didn't know who."

"That's why you probably will not see me in Washington or New York, Joyce. The KGB must also know by now. They'd use it against me in Washington."

"Don't try to anticipate those things, Ernesto," she told him, still speaking Spanish. "You must also consider the possibility that it might work *for* you because they'd hesitate about applying pressures, knowing who and what was standing behind you."

"Joyce, coming?" Matt Hubbard called out from the door of the C-5 on the ramp.

"I'll take good care of Professor Pérez, also, because I know he's one of our special friends, too," she told the governor, still in Spanish. "I'm sorry that Ríos was not."

Obregón nodded and replied in his native tongue, "Ironic, wasn't it, that Esteban destroyed one of his own by accident?"

"Are you certain it was by accident, Ernesto? Or that Professor Pérez was the original target? Or that the KGB wouldn't sacrifice one of its agents for bigger game?"

The military governor nodded. "They have been known to do that. Such are the ways of the world. Joyce, I'm disturbed to see you leave Pascua and return to that dangerous world. Please take very good care of yourself. You are a very special person."

Joyce took her hand out of Obregón's. In a most un-Latin farewell, she threw her arms around him and kissed him. "*Adios, Ernesto. Usted me gusta muchísimo. ¡Vaya con Dios!*"

And she turned and ran toward the plane so that he couldn't see the tears in her eyes.

Captain Ernesto Obregón watched her go. He thought, *How fortunate the Americans to have a woman with such capacity for compassionate love of all!*

In Houston, there was a quiet celebration in Mission Control. It wasn't the sort of exuberant boisterousness of a lunar landing, but a quiet round of congratulations, mostly to Joe Marvin while Duke Kellogg sat quietly by, wondering why it was Joe who was the center of respect.

Duke knew he'd tried to follow the book and keep these people pointed in the right direction. Sure, there'd been the unanticipated times when Marvin wouldn't follow procedures and threw the book away. Duke had spoken to Joe about that, and they'd had a little confrontation in Mission Control. But, by

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and large. Duke was pleased with himself and what he considered to be his people. He was still confused about what had happened to Jackie Hart and why he had insisted on coming back aboard the *Kitty Hawk*. Or why Hap Hazard wanted to ride back to Houston with Frank in NASA 905. He'd call Frank into his office in a day or so and get the full story . . . or so he thought.

He didn't know that others had watched him during this operation, and he didn't know they had other plans for Duke Kellogg.

Alfred M. Dewey also watched takeoff on the little TV set he'd brought to his office. He'd grown to know that office very well in the past several weeks. He put off the urge to telephone the Chilean *chargé d'affaires*. Later, perhaps. Joyce Fisher would be back in a few days, and he'd give her the continuing job of working with the Chileans. Maybe he could even get her a boost in grade if not a step increase. And he'd have to put in the request for Nash Sullivan's replacement. Dewey'd known from the start that State wasn't the place for that young man; he'd been too eager and far too familiar with current technology for State. Nice that Sullivan had been asked to join the staff of the U.N. Committee for the Peaceful Use of Outer Space; he'd do well, and they needed him there.

At 400 Maryland Avenue S.W., Roger Service stepped behind the podium in the sixth floor conference auditorium. "Ladies and gentlemen," he announced pontifically to members of the media, "the *Atlantis* is on its way home, as you saw in the TV transmission via satellite from Easter Island. We expect the *Atlantis* to be operational thirty days after NASA technicians have carefully inspected her and replaced the damaged tiles.

"As for the crew of the *Atlantis*, the Administrator is pleased to announce that the President will award the Presidential Medal of Freedom, the nation's highest civilian award, to each for meritorious contribution to the national interest of the United States in saving the *Atlantis*, which is one-fourth of our nation's manned space capability . . ."

Casey Laskewitz didn't hear the takeoff of NASA 905 from Mataveri, nor did he know of the press conference in Washington. He lay in an intensive care unit in the sick bay of the *Kitty Hawk*, alive, barely conscious under heavy sedation, and wired to a bank of instruments that were saving his life—instruments that had come from the space program he so dearly loved and which had almost cost him his life.

Nor was the takeoff of NASA 905 audible to Jackie Hart and Lew Clay in the trauma unit of the *Kitty Hawk's* sick bay. In any event, the two of them had other things on their minds, mostly each other. They didn't know that the carrier was making more than 30 knots toward San Diego; they only knew that each had found something neither of them had ever had before in their lives.

NASA 905 continued her climb in a left turn that brought Rapa Nui into Frank King's view.

How small it was! Over a thousand people lived there isolated from the roar of the world until now. Ready or not, they were part of it because of the communication satellite and the jet airplane.

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Frank looked at Rapa Nui closely as it swept astern.

He knew he'd never see it that way again. The hurricane of change would now pass over it.

Rapa Nui went from sight behind the 747, and he turned to his business as flight observer, relief pilot, and the commander of the *Atlantis* responsible for getting her home again.

It was time to go. He'd never wanted to go back to Seabrook as badly before. He had to get there as quickly as possible. His life and the world would never be the same again because they'd grown immensely on the Island at the Center of the World.

Hap Hazard entered the flight deck through the aft bulkhead door, closed it and leaned against it. "She's riding fine, Frank," he reported.

"How are you holding up, Hap?"

"Okay. Uh. Frank, I . . . uh . . . kind of got a new perspective on a lot of things in the last few weeks . . ."

"Welcome to the world, Hap," he said, unconsciously repeating something he'd been told.

"I did. Really. Maybe Landsat-XIII's more important right now than that space station I've been all hot about . . . and madder than hell that nobody takes seriously, even with the shuttle lift capability. How's a lunar base going to help the Pascuans? On the other hand, the Landsat may do them some good."

"Hap, old buddy, I've got news for you. *Both* things can't help but do some good for the Pascuans and everybody else. This is a big, complex system we're in, and it's impossible to figure out how something's going to affect something else. Who ever thought that the *Atlantis* would affect the world's most remote island the way it did? Don't try to figure out the future in detail, Hap. The world's changing. Even Pascua's changing. We can't stop it. I'm not sure we'd want to. We can't freeze the world in the condition it's in now, not when people kill each other even on Rapa Nui."

"Amen, brother. Frank, I've never figured out that terrorist raid. Why'd they do it? Why'd they want to destroy the *Atlantis?* Why'd they pull a suicide raid with no way to get off the island if the Catalina was damaged?" Hap sounded perplexed because the lack of apparent rationale behind the raid had bothered him.

"Are you sure it was a suicide raid, Hap?"

"What do you mean?"

"They pulled it off the morning the Soviet ships were originally supposed to arrive . . . if it hadn't been for that typhoon. There were inflatable rafts in the PBY, Hap. Maybe they'd planned to be picked up by the *Kharkov* or *Sverdlov.*"

"And they got caught by the Law of Murphyovitch," Hap added. "But I still can't figure out *why* somebody would want to try to destroy the *Atlantis.*"

"I'm not sure I want to take the time to try to figure it out, Hap. If the world's changing, I've got to work like hell to make it change the way I think might make it a little better instead of making it worse. The way people have been running it can't possibly work in the long run. I like to think we're growing beyond that . . ."

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Hap looked at the command pilot of the *Atlantis* for a moment, then said, "You're right. Things have changed. You've changed. Never heard you talk like that before. It's been a rough time for all of us."

"Hap, growing's always rough." Frank stretched, the tension of weeks now beginning to drain away. "Hey, any place below to grab some sack time? It's six hours to Santiago, and we don't meet the KC-10 tanker for about two hours."

"Frank, have you ever tried to sleep on a fuel bladder?" Hap wanted to know.

"You mean NASA can't even keep the john working on this airplane?" Frank asked. "Sorry. I thought you said something else."

"Come to think of it, they're something like a firm water bed at that. Could be worse on a long flight. And Pascua's a long way from everything."

"Don't be so sure, Hap. Everything important just might have been right there at the center of the world . . . at least for a few short weeks." ■

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BY SPIDER ROBINSON

Assorted titles, Gregg Press series, pages and prices vary
Best Science Fiction Stories of the Year, ed. Gardner Dozois, Dutton, 225 pp., $11.95
The Last Defender of Camelot, Roger Zelazny, Pocket, 282 pp., price unknown
Foreign Constellations, John Brunner, Everest House, 188 pp., $8.95
Time Travelers Strictly Cash, Spider Robinson, Ace, pages & price unknown
The Health Hazards of Not Going Nuclear, Petr Beckmann, Ace, 260 pp., $2.50
A Step Farther Out, Jerry Pournelle, Ace, 384 pp., $2.50
Dream Makers, Charles Platt, Berkley, 284 pp., price unknown
The Search For Life On Mars, Henry S.F. Cooper, Holt, Rinehart & Winston, 254 pp., $10.95
Inside Dance, Murray Louis, St. Martin's Press, 163 pp., $11.95

Analog's new production schedule has several effects. It brings you 13 issues a year instead of 12. It gives authors, for the first time in *Analog*'s history, the opportunity to see and correct galleys of their story before it sees print—a break for all concerned. It has one other effect, which nobody but me seems to find tragic. It changes my position, in two senses.

It increases my delay lag.

"It's not that much of a change," Doc Schmidt assures me. "Only another month." I get a different figure myself, but let that pass: assume a month. That is enough to turn a difficult situation into a well-nigh impossible one. It raises my delay-lag to an average of seven months. Best case, five months; worst case, eight or nine. Just enough to break the camel's back.

What this means is that if I read a book *the day before I sit down to write this column,* you will not read what I have to say about that book until half a year later. If I read it the day *after,* add three months. By that time it will be difficult if not impossible to locate a copy of the book. I am in the position of a man lasering you information from a point almost 3-1/2 trillion miles or 5-1/2 trillion kilometers away—about half a trillion miles further away than I was last column.

My position therefore changes in another figurative sense: from that of a reviewer to that of a critic.

I do not *want* to be a critic, discussing last year's books with those who have already read them. I want to be a reviewer, a consumer guide hipping you to the worthwhile and warning you of the meretricious. It is extremely difficult to do this from 3-1/2 trillion miles away. I tend to get galleys for hardcovers about two months before publication—not soon enough. I get original paperbacks for review *simultaneous with publication*—much too late. One of my editors tells me that these days he feels good if he can keep a book generally available for sale five months after its release.

So as I approach lightspeed, my mass

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increases, to become . . . ahem . . . critical. That is, to the point at which I tend to become a critic rather than a reviewer. This is nobody's fault and cannot be helped. All I can do is try to concentrate on hardcovers, so that by the time my review reaches you, they'll be just about to come out in paperback. This will not, I predict, overly delight the hardcover editors; I can only say that I am open to suggestion.

First the bad news. Now, the books I have chosen to discuss this time are [illegible] books.

* * *

I don't have any new hardcover novels ready for this column—none that I received in time to do them any good by discussing them here—but I *do* happen to have some Gregg Press re-issues, which are timeless.

First, of course, because they are re-issues, for which timeliness is not a factor. Second, because Gregg Press titles, where they can be obtained at all, are not shuffled in and out like hopeful kazoo soloists on Amateur Night; if nothing else they can still be mail-ordered from Gregg several years after release whereas last year's paperback, unless it did very well, can probably *not* be mail-ordered from its publisher). And third, of course, because they are virtually indestructible artifacts, genuinely hardbound and printed on acid-free paper one day your heirs and assigns will squabble like hell over possession of them.

The astonishing thing about Gregg editions is that they are priced competitively with contemporary "hardcovers," that is, with pulp paper glued into a stiffened cardboard frame.

They're also a godsend to a reviewer with deadline-delay-lag problems, because at least half of every shipment are Old Friends I can recommend to you without having to open them (although I will, I assure you, as soon as I get a minute).

This month, for instance, the Gregg package contained the following Heinlein novels: *Double Star* ($10), *The Door Into Summer* ($12.50), *Glory Road* ($12.50), and *The Puppet Masters* ($11). It also contained a book indispensable for the Heinlein completist: *Destination Moon* ($15), which contains Heinlein's novella of that name (originally published in 1950, anthologized once in 1958), plus his lengthy essay on the filming of the movie version (the first—and damn near the last—attempt at a real science fiction movie), plus pages of photographs and PR copy for the movie, all put in perspective by a knowledgeable and enlightening Dave Hartwell introduction.

Also in the box were Zelazny's immortal *Lord of Light* ($14) and his lesser-known but possibly more ambitious *Bridge of Ashes* ($10); both are simply must reading.

And finally, if I may stray a bit from the confines of the subhead, there is an excellent reissue of the 1977 Berkley paperback collection, *The Worlds of Frank Herbert* ($13.50). It offers nine Herbert stories from the '60s, about half of them originally published in *Analog*, and displays Frank's strengths to good effect.

Which leads us to:

Story Collections

Of the 11 stories in Gardner Dozois's 9th annual collection of the **Best Science Fiction Stories of the Year,** 11 are good. In fact, most of them are very good, or better—fine writers working at the top of their form. You may not

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care for every story in the book (one or two weren't precisely my own cup of coffee), but I'll be very surprised if you don't enjoy a clear majority of them, and find at least two or three superb. Each writer accomplished what he or she set out to do—a striking achievement regardless of whether you feel the thing was worth doing (I did in nine out of 11 cases).

How closely Gardner's taste approaches that of the world in general can be seen from the fact that his 11 selections include two Hugo winners ("Sandkings" and "The Way of Cross and Dragon," both by George R.R. Martin), two Nebula winners ("Sandkings" and Ed Bryant's "giANTS"), two Hugo finalists ("giANTS" and "The Battle of the Abaco Reefs" by Hilbert Schenck), and four Nebula finalists ("Camps" by Jack Dann, "Vernalfest Morning" by Michael Bishop, ". . . Cross and Dragon" and ". . . Abaco Reefs"). Six out of 11 stories either won or were finalists for major awards; pretty good handicapping.

Of course no single volume could contain all the good or even really good stories published in any one year, so Gardner appends a list of 105 Honorable Mention titles. Here I begin to have some complaints. There are only four or five stories that I don't think belonged on the list—but there are some crucial omissions. (No space to list either group.) This is of course inevitable; the list reflects Gardner's tastes.

He also supplies an 18-page summary of the year 1979 in SF. Again, I cannot say I agree with every opinion in it—I take exception, for instance, to his rather disparaging view of *Analog*—but there is only one *fact* cited that I know to be false (the contention that my Callahan's Bar stories have "followed Bova to *Omni*"). And there are a great many more facts than opinions in the summary; it is quite thorough, reliably researched and pretty well-balanced.

All in all you could hardly ask for a better Best of The Year collection.

Next comes Roger Zelazny's latest collection.

I didn't say story collection. Neither did Zelazny; **The Last Defender of Camelot** is subtitled simply, "A Collection By Roger Zelazny." The generally accepted definition of a "story" is a fiction in which one or more characters are faced with a problem and strive to solve it. By this definition, less than half of the 16 pieces in *TLDoC* are stories. Most are anecdotes, or situations, or conceits, which are economically sketched and left standing there. A werebot goes around draining other robots of their energy. A starship pilot, half organic, half metal and plastic, finds his starship a better lay than women. Religious robots painstakingly recreate classic car-crashes in memory of their vanished masters. Cute situations, but not stories. Nobody grows, no problem is solved or even attacked. Call them prose poems. If you agree that the situation is interesting or the conceit elegant—or if you simply enjoy the way Zelazny strings words together—you enjoy the piece.

I report that I enjoyed all 16, and I have a tendency to prefer story to nonstory. My particular favorites were the original novella versions of "He Who Shapes" (Nebula winner) and "Damnation Alley," both superior to the books they later became, "For a Breath I Tarry," "The Game of Blood and Dust," and the title story. It is perhaps worth noting that the first three of these are widely available elsewhere; it also may be noted that none of the remaining

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pieces are more than 10 pages long, some a spare two pages. If you already own both *The Dream Master* and *Damnation Alley*, you own 54 percent of this book.

But if you don't own copies of *all five* favorites I cited, or "Halfjack" or "The Engine at Heartspring's Center," you would be well advised to look this one up.

For "story-or-nothing" fanatics I offer John Brunner's new story collection, **Foreign Constellations.** I'm not certain that there'll *be* a paperback edition; *FC* represents Everest House's first testing of the SF waters—in fact, I'd never have seen a review copy if I hadn't chanced to sit next to Everest editor Mike Cantalupo on a New York-New Bedford bus. You can always order the hardback from Everest at 1133 Avenue of the Americas, New York, NY 10036.

Two of the eight stories, "The Easy Way Out" and "Pond Water," are just a bit predictable, but both are told with typical Brunner competence and craftsmanship. The rest are superior stuff, stories that will stay with you a while. The standouts are "The Suicide of Man" (a remarkable story of evolutionary transcendence), "What Friends Are For" (concerning a robot babysitter of great insight), "The Berendt Conversion" (a chilling tale of future food riots), and "Out of Mindshot" (concerning the unsuspected hazards of enslaving a telepath). A taste of most subtle humor hovers over "The Taste of the Dish and the Savour of the Day," a tall tale about the perfect food. The only story *I* had trouble swallowing (forgive me) was "The Protocols of the Elders of Britain," which struck me as an exercise in pure paranoia. (The punchline is that our leaders are sadistic monsters.)

In these troubled times, it's nice to see a publisher getting *into* SF—especially with a book as tasty as this one. And I've been missing Brunner, these last few years.

One more story collection to cover, before I go on to works of fact. (I have no new *novels* here that Tom Easton hasn't already covered. But if you missed his coverage of Greg Benford's *Timescape*, don't miss the book itself, okay?) The only collection which I have reason to *know* will be available in paperback about the time you read this is my own next collection, **Time Travelers Strictly Cash.**

It is by way of sequel to *Callahan's Crosstime Saloon*—at least in part. That is, half the fiction content is stories set in Callahan's Place, the bar where *everybody* listens to your troubles. The book was supposed to be strictly a Callahan's collection—but for reasons discussed at length in the foreword, I ended up including four non-Callahan stories, and threw in three non-fiction pieces and a sprinkling of commentary for dessert. Also, in the foreword I finally reveal the Truth about Callahan's Place (I lied a little in the first book).

I give it the Reviewer's Second Highest Accolade: "Just the way I'd have done it myself." (The highest accolade is "Better than I could have done it myself." It is also the rarest.)

Fact

One of the most sincere compliments I ever received was given me by a Dean of Men. He had called me in on the carpet (at 2 A.M.!) to hear my version of a recent sequence of events in which he felt I was involved. Unbeknownst to me, he had hard evidence. I talked myself blue in the face for 45 minutes, and

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when I was done he sat there for a minute, then shook his head in admiration and said, "Mr. Robinson, you are the best liar I have ever met in my life. If I didn't *know for a fact* that you're lying, I'd believe you."

As I write this, the citizens of the state of Maine have just voted to continue using nuclear fission for power generation, and I'm enormously relieved. Nova Scotia cable subscribers get three Maine TV channels, and after watching the appalling weeklong media blitz by the antinuke kukes, I was terribly afraid they were going to succeed in shutting down Maine Yankee. I'm here to tell you I've never seen such an effective propaganda campaign in my life, on any issue; I mean, they were *smooth*.

If I didn't *know for a fact* that they were lying, I might have believed them myself.

But as it happened, a week before the Maine referendum, I had received a review copy of Petr Beckmann's new Ace paperback. So I was vaccinated.

It is packaged with satanic cunning by Ace's departing SF editor, Jim Baen. (Now with Tom Doherty Associates.) I have never been able to decide whether Jim is very canny or very uncanny. If you glance hastily or carelessly at the book, its nature seems obvious. Cover painting of a reactor complex, ominous pressure-vessels stark against the sky, surrounded by a flimsy chain-link backyard fence, vulnerable-looking deer in the foreground. Big white letters: "THE HEALTH HAZARDS OF GOING NUCLEAR." The author's name is not given as "Petr Beckmann, Ph.D." but as the more yokel-attracting "Dr. Petr Beckmann." So if you are an antinuke sympathizer, you look no further and pick up a dozen copies for your hardheaded parents and apathetic friends.

You fail to notice, until you've got it home, the single word which comes between "OF" and "GOING" in the title. It is in *red* type rather than white, and it almost perfectly disappears into the deep blue sky over the reactor vessels, and it is the word "NOT."

Then, much too late, you notice the small print above the title: "Every time a nuclear plant goes off-line, people die."

When I read the book, a week *before* the Maine propaganda barrage, I had very mixed reactions. Delight, of course, was the strongest: all the pronuke arguments I knew were well presented and well documented; several I *didn't* know were as compellingly adduced; and virtually all of the classic antinuke shibboleths were utterly, elegantly demolished. What Beckmann does is compare the hazards associated with various forms of energy production, *per billion MWh of electric power produced*, in terms of deaths, diseases and injuries. Simple arithmetic tells the tale—and for antinukers who can't do arithmetic, there are visual aids. Moreover, Beckmann is more than easy-to-understand, he is massively readable—the pages demand to be turned. He pounces upon antinuke arguments, and tactics, and spokesmen, and savages them with his teeth.

That brings us to the other side of my reaction: mild dismay. After a while the rhetoric, the sarcasm, the heavy irony, the character assassinations, the obvious anger began to make me a little uneasy. And the book closes with what seemed an ill-advised chapter in which Beckmann speculates on the motives of the more prominent antinuke leaders. He is willing to concede that the rank-and-file majority are well-meaning idiots, concerned enough about their future to trash reactors but *not* enough to

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no arithmetic. But he feels that at least some of the leaders are much too clever and well informed to actually *believe* the bullshit they speak, and therefore he must account for their dogged devotion. His theory is that they are elitists dismayed by the general increase of wealth because it means that the gap between them and the presumptuous peasants is narrowing, because *general* wealth actually devalues individual wealth. Therefore, says Beckmann, consciously or unconsciously they support any cause which will promote poverty and hardship for the general populace, believing themselves immune. This struck me as illogical and paranoid, and underlined my mixed reaction to the book.

—a week before the antinuke campaign peaked in Maine.

Then when I sat in front of my Toshiba for a week straight and listened to rhetoric, sarcasm, irony, character assassinations, shameless deck-stacking, subtle conditioning techniques and brainwashing methods, most especially when I heard known falsehoods repeated over and again, even after they had been exposed and refuted—when I saw the terrifying skill and utter dishonesty of the New Luddities—I changed my mind and decided to recommend Dr. Beckmann's book to you unreservedly. I intend to purchase a dozen copies and give them to my antinuke acquaintances. Let us fight fire with fire, sarcasm with sarcasm, rhetoric with rhetoric, stand up to the buggers sneer for sneer. Let the only difference between us be that one side has truth and the other scary stories. I still don't buy Beckmann's conspiracy theory completely—but I like it better than the theory that fission power is a conspiracy of ivory-tower scientists and pig corporation executives.

Above all, let us fight bullshit with fact, guesswork with arithmetic, illogic with logic, let us for Christ's sake look at the facts. Happily, that is what Beckmann has accomplished best. (Specimen fact: plutonium, the "most toxic substance on Earth," is just 10 times more toxic than the caffeine I have just finished putting in my system, and 50 times *less* toxic than the pesticide arsenic trioxide, which has a half-life of *infinity*.)

If only 59 percent of the Maine voters were able to ferret the truth out of what was presented to them, it's time we started spreading the word. Past time. To employ a classic antinuke "argument," I don't want my kid to grow up breathing coal.

All of the above enthusiasm applies to my recommendation that you run out and purchase several copies of Jerry Pournelle's new book, **A Step Farther Out.** Both this and Beckmann's book are paperbacks, already released as I write in September 1980—I'm breaking my new hardcover-only injunction; both of these will probably be at least somewhat difficult for you to locate. I tell you that it is your patriotic duty (patriotism to your *species*) to go to the trouble of ordering them, direct from Ace's own mailing service if you have to (PO Box 690, Rockville Center, NY 11571), and furthermore to go around forcing them on your non-SF-reading friends.

Jerry's book is better written than Beckmann's (but bear in mind that Beckmann moved to the U.S. from Czechoslovakia only 13 years before he wrote *THHoNGN*). It is also more ambitious in scope: Jerry doesn't limit himself to the nuclear question, he demolishes *all* the idiots. Only-One-Earthers, Limits-To-Growthers, self-trained "ecologists," anti-space-pro-

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gramers and antitechnology Luddites of all kinds are herein dissected and hung out to dry, and the truth is told in plain English and honest figures. The marvelous, mind-boggling possibilities for Survival With Style are explained so that anyone can understand them.

ASFO is a collection of the columns which Jerry published in the old Baen *Galaxy*, substantially rewritten for book publication. His thesis is simple: throughout history only one factor has ever acted to limit population growth, and has done so consistently. Not war, not pestilence, not famine: they *increase* population. The only limiting factor is *wealth*. (Look at the U.S. birthrate.) Let us, therefore, says Jerry, make everyone wealthy. Fortunately, he goes on, this will be a simple trick. . . .

And then, by God, he proves it.

Along the way he pauses to tell you about black holes and stardrives and the impossibility of an Asteroid Belt-wide civilization and assorted promising new technologies and the wild ideas that get talked about quite seriously at AAAS conferences, and a thousand other fascinating things that *Time* and *Newsweek* somehow failed to tell you about. Jerry has Asimov's Gift for explaining technical matters to the layman and his own unique constitutional inability to suffer fools—he is considerably more restrained than Beckmann, but just as devastating.

I should pick some nits in style and presentation here, to demonstrate my critical objectivity, but to hell with it. This is not a perfect or unassailable book any more than Beckmann's is, although it comes much closer.

But the streets out there are full of scared people, so terrified and demoralized they're ready to flush themselves down the toilet (and you and me with them), just because nobody ever sat down and patiently, carefully, intelligibly, *cheerfully* explained to them how the world works, calmed their fears and brought them hope. The reason vs. unreason, science vs. superstition, technology vs. wishful thinking scrap is The Big One these days. Always has been, but the crisis is upon us now. The only thing that can save us is the truth, widely and loudly proclaimed. If you don't want yourself and your loved ones to die untimely, see that this book is read by as many citizens as possible.

Dream Makers, by Charles Platt, is a collection of interviews with 29 of SF's most prominent and/or interesting writers and editors. I tend to like interviews in general, but these are some of the best I've ever seen. Platt does an exemplary job at the difficult task of providing a *balanced* picture of each of his subjects: without either hero-worshipping or muck-raking he manages to create the illusion of bringing living, breathing people into your living room. Injecting precisely enough of his own subjective personality into the pictures he draws, Platt held me spellbound for hours. His portraits of the writers I happen to know personally are them to the life, and those of writers I don't know convey that elusive ring-of-truth. Moreover he seems to have somehow gotten each and every one of them to open up like a clam for him. I might have know that the man who wrote *The City Dwellers* and created Avon's late, lamented "SF Rediscovery Series" would do a good job at whatever he turned his hand to.

Worthies interviewed are Asimov, Disch, Sheckley, Vonnegut, Hank Stine, Spinrad, Pohl, Delany, Malzberg, Bryant, Bester, Cyril Kornbluth's widow Mary, Budrys, Farmer, van Vogt, Dick,

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Ellison, Bradbury, Herbert, Knight, Wilhelm, Moorcock, Ballard, Tubb, Watson, Brunner, Greg Benford, Silverberg and Aldiss. What more do you need to know?"

One of the books cited on the Acknowledgements page of *Stardance*, a novel by Spider and Jeanne Robinson, was *A House In Space* by Henry S.F. Cooper. Cooper is a science writer for the *New Yorker*, and *AHiS* was an absolutely fascinating account of what it was like to live aboard Skylab. So I fell with a cry of delight on his newest, **The Search For Life On Mars.** I've been interested in the subject for as long as all of us in SF—since I could read. But whenever I tried to pin down exactly what the Viking landings proved—is there life on Mars, yes, no, or maybe—the answer kept coming back, "Well, it's kind of complicated . . ."

Cooper explains both how and why the answer is complicated, explains the factors that didn't make the papers or the six o'clock news, gives you the blow-by-blow of one of the most bitter controversies in the history of biology. He manages to make you understand how it came about that megabucks were spent to design and deploy on the surface of Mars instruments to answer a single specific question, without producing an interpretable answer.

It's a story of warring opinions, battling egos, intellectual cut-and-parry. Cooper makes it real, makes you understand what would make Wolf Vishniac go out and *die* for his opinion, makes you see why some scientists *need* to disprove Percival Lowell's Mars just as badly as "Old Crazy Carl" Sagan *needs* to believe in it. Cooper makes you feel the frantic confusion and anger of the combatants as the data began to come in and make monkeys of all of them in turn, refusing to give a clear-cut victory to either side, destroying theories as fast as they could be generated. It's a brilliant hard science fiction story, except that it has a New Wave ambiguous ending and is all true.

My only complaint is that, inexplicably, there is not a single God-damned illustration. I had to spend hours locating my color Viking shots and lander specs in my "files" so that I could *see* what Cooper was talking about, and I would much rather have paid a couple of dollars extra for the book. Oh well, maybe NASA wouldn't geek for some reason. Foolish of them, if so.

Nonetheless, I recommend the book. It is subtitled, "Evolution of an Idea," and I had not realized quite how stormy evolution can be sometimes. The depressing bottom line, of course, is that the biggest and most expensive block of data from the Viking Project accomplished nothing significant, was in fact, in the final analysis (dare I say it?) a waste of some of the taxpayers' money. Something we must never ever allow NASA to do again. Oh, Viking repaid its investment, but not as well as it might have, and Henry Cooper can show you how that happened.

Another source cited on the Acknowledgements page of *Stardance* was the series of columns that legendary Modern dancer/choreographer Murray Louis published in *DanceMagazine* during the months in which Jeanne and I were writing our story. I know this may not seem to have much to do with SF, but the Hugos and AnLab results convince me that you *Analog* readers enjoyed "Stardance" and "Stardance II," and Murray Louis's columns are part of the reason why, so I'm going to tell you about them. They have just been collected into a book called **Inside**

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Dance, and if you liked our story I think you'll like Louis's book.

If you are completely unfamiliar with the world of Modern dance, perhaps I can convey something of Louis's stature by mentioning that Nureyev, by no means a Modern dancer but a ballet superstar, danced Murray Louis's choreography with Murray Louis's company in New York. This is roughly equivalent to being, say, a science fiction writer with whom Truman Capote is willing to collaborate, or a jazz band with which Itzhak Perlman likes to jam. This of course does not indicate Louis's talent—only his fame—but I saw that show, and I've seen other examples of his choreography: the man is *good.*

He is also a warm and perceptive and sensitive and much-loved man who happens to write like an enchanted son of a bitch. I tell you that being married to a dancer with whom I am fairly telempathic did not teach me as much about *what it is like to be a dancer,* about where that life pinches you and where it feels good, as the columns collected in *Inside Dance.* Many of the insights Louis shares so eloquently can be applied by analogy to all artists, even SF writers (there's a marvelous chapter "On Critics," for instance); and some of them are absolutely unique to those most gallant of all artists: dancers. ■

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BRASS TACKS

Dear Dr. Schmidt:

I want to correct a statement in "Brass Tacks" (October 1980) by Dave Weeks.

The Moon Treaty has NOT been ratified by the U.S. Senate.

The treaty was passed by the U.N. in December '79 "without dissent." Since then, due mostly to the opposition of the L-5 Society, only a few countries signed it. With the exception of France, they are not space powers.

For the treaty to become legally binding on the U.S. the president would have to sign the treaty and send it to the Senate for ratification. There it would be considered by the Foreign Relations Committee, and, if they buy it, the treaty would be submitted to the entire Senate for a vote.

How the Senate would vote on this topic is anyone's guess, but a majority (eight members) of the Foreign Relations Committee has gone on record opposing the treaty.

Given the poor chances of getting the treaty ratified, the president, not anxious for another SALT debacle, did not sign the treaty and seems unlikely to do so at least until the end of 1980.

The blocking of the Moon Treaty is a clear example of the emerging political power of the space lobby. While the L-5 Society played the major role in opposing the treaty, we freely acknowledge and appreciate the activities of many other groups with similar goals and the science fiction/space-related magazines. Your support was critical.

This ongoing effort to preserve freedom in space is very expensive. The State Department and NASA can assign dozens of experts and spend several hundred thousand dollars to convince Congress of their position. In order to successfully oppose these bureaucracies the L-5 Society had to hire Leigh Ra-

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tiner, a well-known lobbyist and authority on resources in international jurisdiction, to direct an effective campaign against the Moon Treaty. People like Mr. Ratiner are rare indeed. He understands the issues, the power structures in Washington, and is sympathetic to our cause. Leigh and his staff are worth every penny his law firm charges.

If any readers wish to be associated with this historic opposition to imposing onerous limits on the rights of future space dwellers, please send your donation to the Moon Treaty Fight, c/o the L-5 Society, 1620 N. Park Ave., Tucson, AZ 85719.

With your help, the next time the Moon Treaty comes up we will slap it down again.

H. KEITH HENSON
Fundraising Chairman
Moon Treaty Fight
Tucson, AZ

Dear Stan,

Just read "Moment of Inertia" (October 1980) on the train. Liked it as a story, but can I join the rush of people, headed no doubt by Jerry Pournelle, objecting to the science?

Who needs 50G acceleration? ONE G, sustained, would be enough to get *anywhere* in a reasonable time, and I'd like to know what those guys (and gals) were using for (reaction) mass, especially with an enormous mass stuck on the front of the vehicle. Charles Sheffield has very neatly solved the wrong problem, as far as star travel is concerned!

JOHN GRIBBIN

One G will get you anywhere in a reasonable time if you don't care about coming back home in a reasonable time. Fifty G lets you do that, too. As for the drive problem—needless to say, Charles's solution to that one is very exotic, and he didn't want to get into it in this story. But he does in a forthcoming sequel (which may have already forthcome by the time this sees print).

Dear Mr. Schmidt,

I enjoyed reading the article by Milton A. Rothman entitled "Death Risk" (August 1980). He made several good points in the article, and provided insight into a number of items I had intuitively accepted, but never really *thought* about. In particular, he described the effect of doubling the death rate on a given population. He said: "Suppose a catastrophe occurs that causes the probability of dying each year to double." The results, he showed, were a reduction of lifespan by 8.6 years (sliding over the curve by 8.6 years would have the same result). I've thought about it, and such a catastrophe *has* occurred . . . to *half* the population! (At birth. After a while, they get to be *much less* than half.)

Half the population has been born with a missing arm on one of their "X" chromosomes. This abnormality causes them to have a shorter lifespan by about 8.6 years (I don't think that figure is exact, but it's fairly close). The half of the (at birth) population with this genetic difficulty are called *males*.

The risks of childbearing, in pre-obstetric human history, more than offset this advantage in the female population; but now, "all things being equal" as far as infectious diseases are concerned, the *true* genetic effect of that lopped-off chromosome arm becomes apparent.

I'd always believed that the additional lifespan-increment that the female half of the population had was a 10-percent factor, and could be accounted for by environmental factors,

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or the "luck" of an oppressed "minority" which has less of the authority in this society, but also less of the responsibility. I was wrong. Mr. Rothman's article reveals the startling (to me!) fact that men have *double* the death rate per year than women. That's not just a 10-percent factor!

Unfortunately for you and me, Mr. Schmidt, we're in the wrong "half" of the population to have a long lifespan.

Thank you, again, for printing Mr. Rothman's article. I'm glad to see that, as usual, Analog doesn't take it for granted that their readers will be "scared off" by the application of numbers to a problem. I'm looking forward to more of the same in future fact articles.

PATRICK J. O'CONNOR
6315 W. Raven St.
Chicago, IL 60646

Stanley Schmidt, Editor:

Spider Robinson's review of *The Stand* (page 171) and the letter from Peter Wolozuk (page 178) in your August 1980 issue, just received:

These tie together, in a way. Robinson's pro-rationalism argument sounds hot off the anvil, fervently eloquent, and I agree with every word. One of the things some of my own colleagues have forgotten is that education ought to be part of the never-ending fight against fuzzy thinking and wishful thinking. Wolozuk refers to artists "venturing into chaos in order to escape an overly ordered world" forgetting that until the years when science/technology began accelerating, artists were almost entirely structured and ordered themselves. It was their panic, and their lack of understanding, when technology hit them, that led to such deliberate rejections of "order" (read: rationalism). Of course, they want and need a certain amount of order and rationalism; when an artist purchases a certain raw material, such as paint or clay, he expects it to be essentially identical to the last batch, and usable in the same way. He needs and depends upon a rationalized world in order to seek his chaos.

Wolozuk follows up with what I interpret as a slur on scientists: he says the scientist "seeing chaos, proceeds to order it in an effort to expand the universe of those who cannot live without order." The implication appears to be that the scientist merely serves the purposes of totalitarians. Mr. Wolozuk might consider that *everyone* is in the condition of not being able to live without order. (See above, on the artist's need for order in the marketplace of materials.)

It's all right with me if an artist rejects technology and seeks chaos and produces works that say all is chaos or ought to be. The trouble is, since that point of view arose, which I would date roughly in the late 19th century, it has convinced not only the general public but also cultural opinion leaders to reject rationalism and to embrace chaos, or emotionalism, or feeling, instead of objectivity. We get people who make serious judgments about personal associates based on astrological signs, and people who stand up at public hearings and shout that they don't care what the figures say, they know how they feel, and after all figures are only statistics. The chaos-lovers seek to persuade us that practicing rational behavior is cold and inhuman. I stand with Spider Robinson in believing it *is* human to make the best use of the brains we got, and terribly *in*human to prefer the pretty fuzzy clouds.

RINEHART S. POTTS
Assistant Professor
Glassboro State College, NJ

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Dear Mr. Schmidt:

Your editorial in the July 1980 Analog is a truly Campbellian exercise. It lacks only John Campbell's knack, drive, demonic possession (call it what you will) for causing heat as well as light. Perhaps your way will prove better.

Your purpose seems clear to me. Ofttimes, one had to ferret out Mr. Campbell's. Once having found it, however, one had no great difficulty following the reasoning to its logical (it was hoped) conclusion. The occasional syllogistic aberrations kept up interest and sharpened the faculties. I think they were intentional.

Be that as it may, I feel that you gloss over, too quickly, two factors that bear heavily on your argument(s):

1. "well informed, perceptive, conscientious populace"

2. "requires a far more effective educational system." I think you have totally ignored another coequal factor:

3. "traditional values and moral certainty."

I will grant the possibility that the latter would complicate your argument and would probably be controversial enough for an editorial of its own. (I will discuss it no further.) That being said, I put it to you that while the first two sets you enunciate may seem to be immediately and intimately related, they are, in fact, totally disparate considering the present structure of our society. If a better educational system were to exist, it would have had to come from a strong desire for its existence on the part of the public. Educational bureaucracies being what they are, all they desire is a smooth flow of paper and no interference in their procurement system. The public would have had to overcome such drives to have attained a better education for its children. To have done that, it would have had to want it very badly. It didn't. It produced the self-centered, greedy "me generation" that wants it less: doesn't need it. Ask them. Their vibes are enough.

So, across the street, those in society who are informed, perceptive and conscientious are shrinking in number and are not being replaced. Thus, not only is a rational discussion of registration (or conscription) difficult, but so is the operation of other basic elements of our historical freedom such as initiative, referendum, and recall, not to mention representative government itself. They too rely on those same public qualities. The result is that we find ourselves ruled instead of rulers. Government runs us instead of vice versa. (I am terribly afraid that it would take more than a few generations of *superior* education to change THAT!)

The U.S. Constitution is a piece of parchment. If it is not seen as valuable—indeed indispensable—to our orderly functioning as a society, it is useless—a hoary anachronism full of self-contradictions (as you point out). Even its sacred guardian, the U.S. Supreme Court, mucks about with it as if it were so much toilet paper. If we are to survive as a society (is that good?), we must not allow either extreme: "hands off" or "quick fix." Contemplate some of the amendments proposed in recent times and pray that some of those few remaining informed, perceptive, and conscientious citizens prevail in interpreting and implementing any useful and workable applications and changes needed.

I will not argue with you the merits or demerits of registration or conscription. (I was conscripted myself once, a LONG time ago.) But I fear your emphasis on so small a slice of the truly monstrous dilemma we are facing tends

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to trivialize it. But then, I hark back to John Campbell. Perhaps by zeroing in on this particular issue you may "stir up the animals" to a contemplation of the larger ones.

Yours for contemplating the forest and not the trees, I remain

WILLIAM A. BARRON, JR.

Honolulu, HI

Treating a sick forest requires attention to individual trees as well as contemplation of the whole tract. We'll work on one this month, another another month.

Dear Sir

Some time ago, when I started going blind, I discovered "Talking Books," a library of taped cassettes dictated by sighted people, and felt I should contribute before needing to accept. As I have been reading SF for the last forty-odd years, that field was naturally my first choice for dictation. However, to my horror, I was informed that not many blind people have complained of the lack of SF (they probably haven't been exposed to sufficient high-quality material to appreciate it) and also, more importantly, the copyright laws are strict and publishing houses are too heartless to relax them, even in favor of people who would not buy the books and magazines anyway. Does this make sense to you?

What I'd like you to do is this: find out for me which authors have managed to stipulate an exemption of copyright for the specific purpose of reading to the blind; what stories, publishers, whatever, whoever permit this dictation; and tell me what I can provide to widen a few horizons before I too am in darkness.

MS. J. READ

110 Lytton Rd.
Bulimba, Queensland
Australia 4171

The United States Library of Congress already has a limited program like this, but there's certainly room for more. Interested authors might contact Ms. Read directly. ■

● Next month artist Wayne Barlowe makes his first Analog cover appearance with a portrait illustrating Timothy Zahn's "Hollow Victory." When diplomacy goes beyond nations and involves representatives of species evolved in radically different environments, it will naturally have to recognize that a "successful" negotiation will have to satisfy the needs of both sides—as judged by their own criteria. And those criteria will ultimately grow out of the environments in which the negotiating species evolved, and may therefore be quite different. So different, in fact, that one race may find it hard even to imagine that the other wants what it *really* wants...

We'll also have a long novelette, "The Venetian Court," by Charles L. Harness, too long absent from these pages. Harness, as you may recall, is a patent attorney, and this tale takes off from an intriguing question in that department: just what is the legal status of the inventions of a computer which was invented to make inventions? Of course, the world (and the legal system) in which this takes place are a wee bit different from ours, and I doubt you'll anticipate all the turns the story takes.

And we'll have Robert A. Freitas' article on "Xenobiology," the first of a pair we'll be running which, together, form a good introduction to current thinking about the forms life might take on other worlds; this one's mostly about biochemistries—and possible alternatives. Plus stories by Edward A. Byers, Paul J. Nahin, Rudy Rucker, and Ian Stewart.

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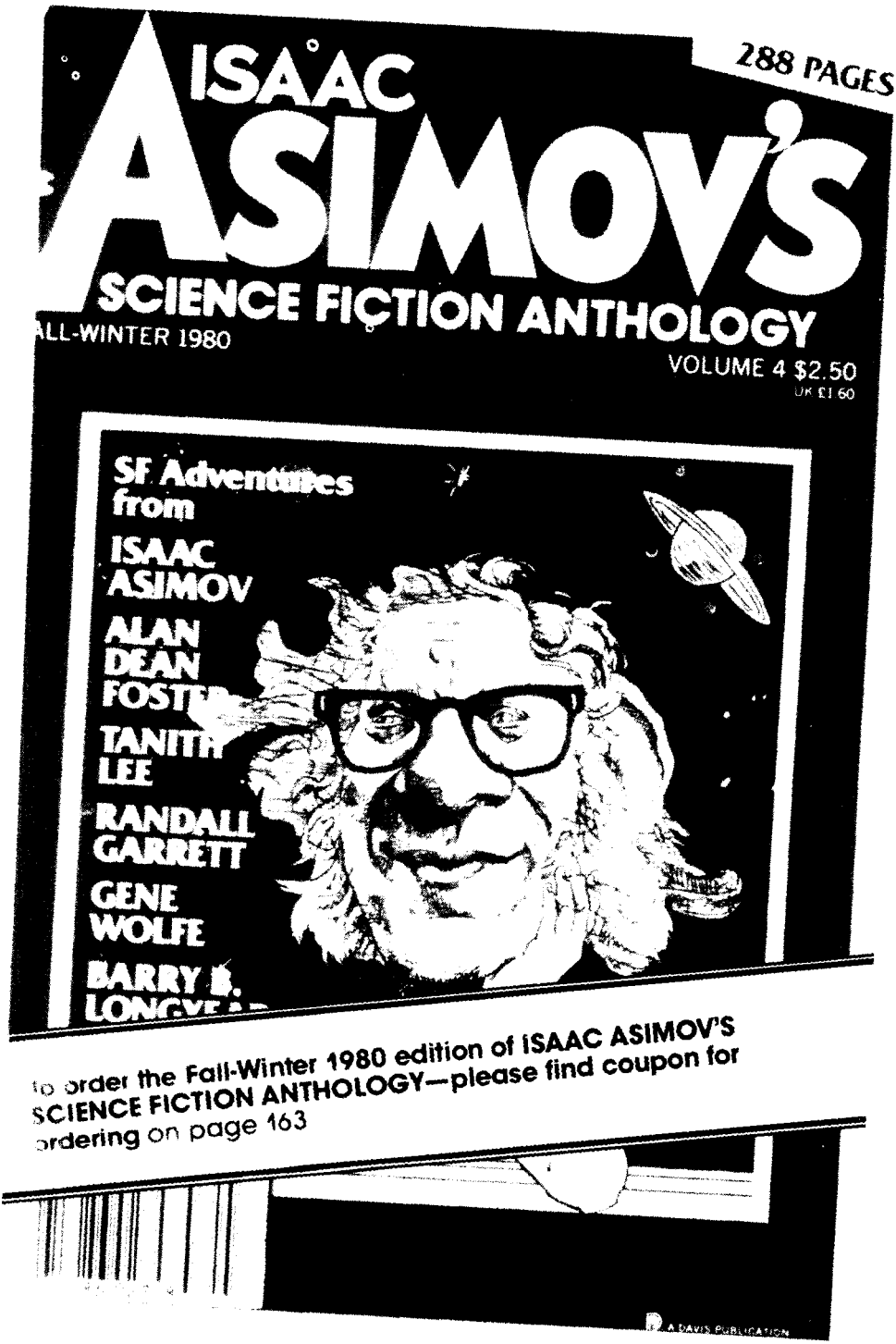

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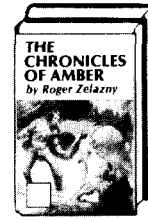

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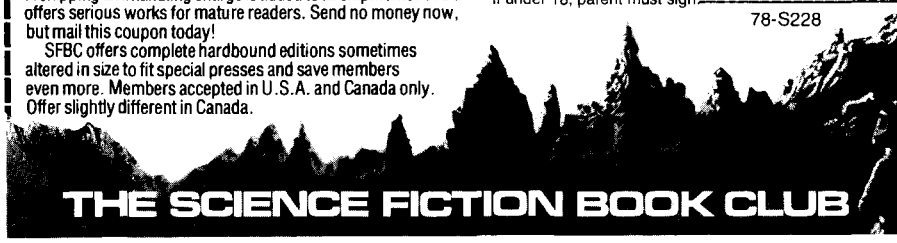

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